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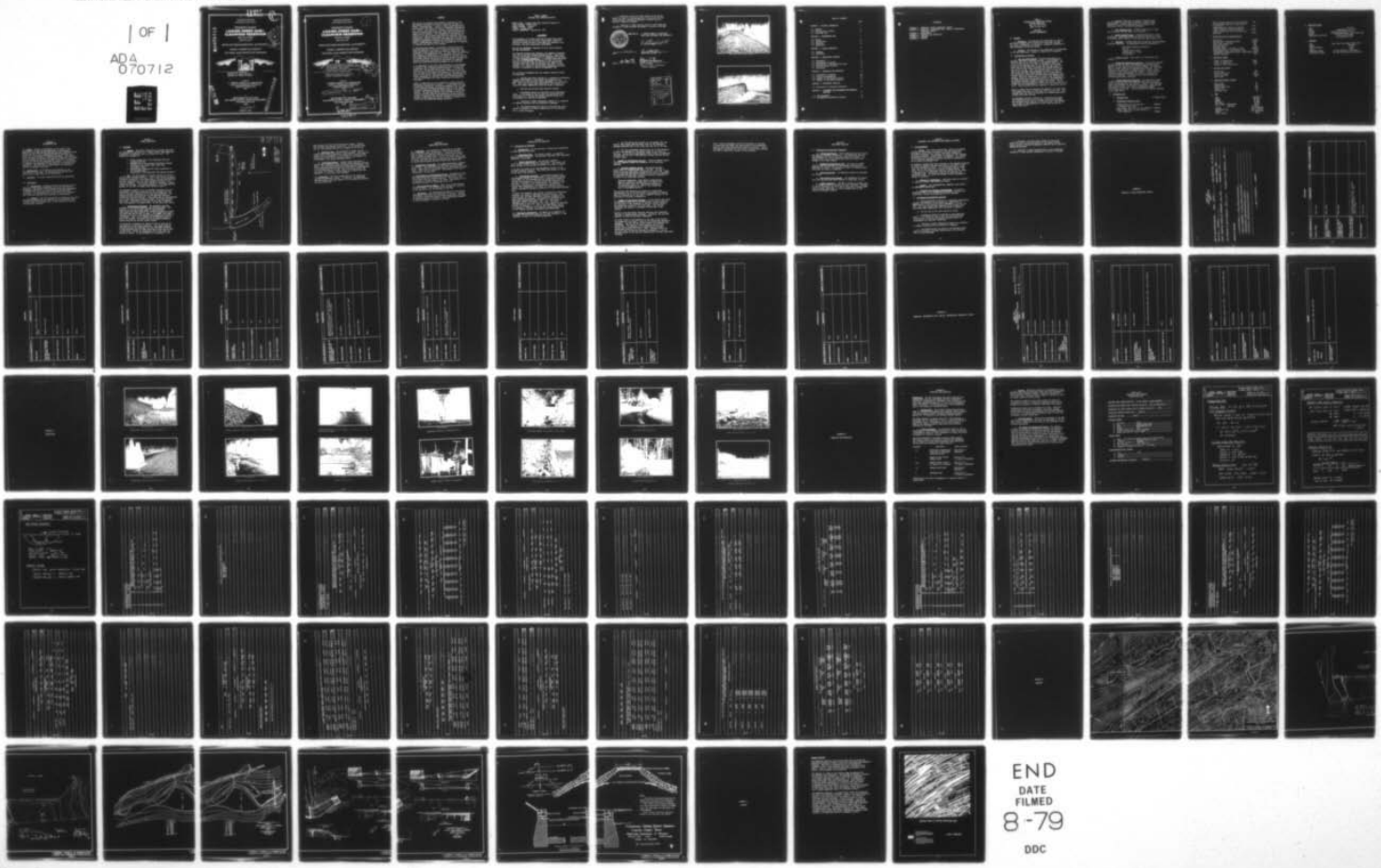

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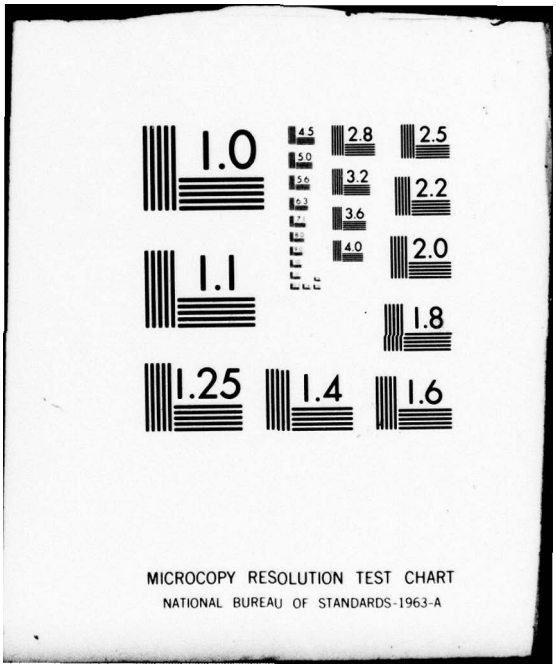
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SUSQUEHANNA RIVER BASIN

LICKING CREEK, JUNIATA COUNTY

PENNSYLVANIA
LICKING CREEK DAM—CLEARVIEW RESERVOIR

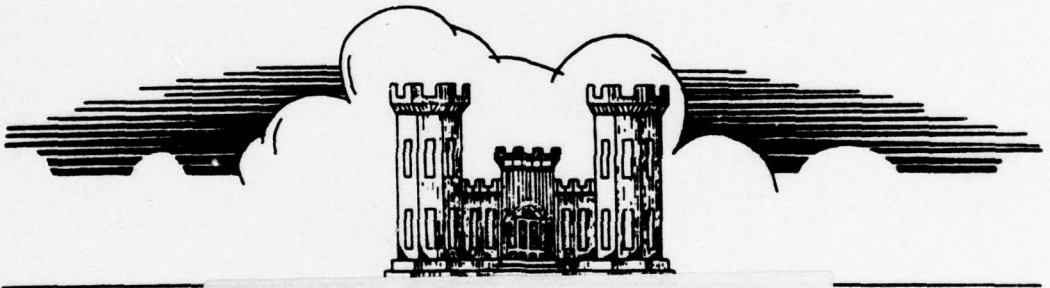
NDS ID NO. PA-00581

DER ID NO. 34-01

MIFFLINTOWN MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



Prepared by

L. ROBERT KIMBALL and ASSOCIATES
CONSULTING ENGINEERS and ARCHITECTS
EBENSBURG, PENNSYLVANIA
15931

For

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

MARCH 1979

SUSQUEHANNA RIVER BASIN

LICKING CREEK, JUNIATA COUNTY

(1)

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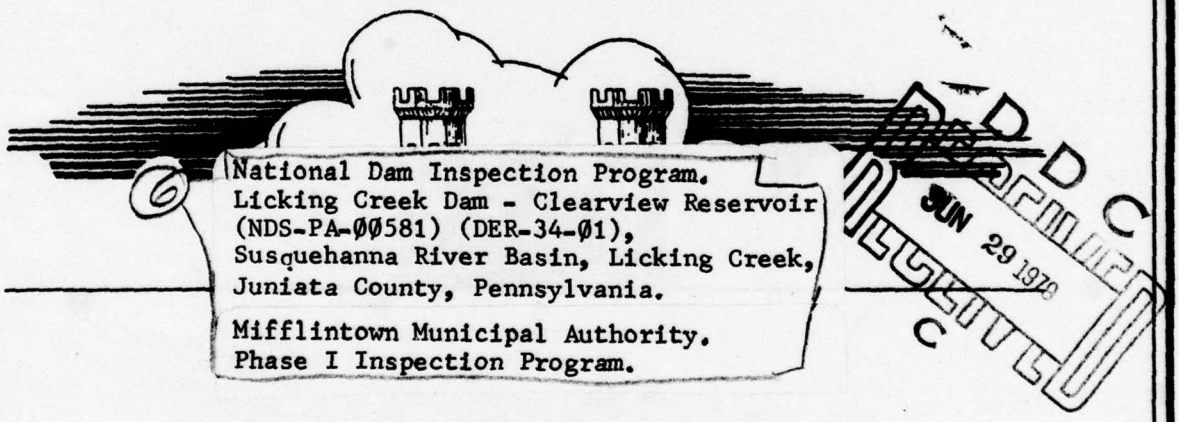

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(15) DACW31-79-C-ØØØ9

For

DEPARTMENT OF THE ARMY

BALTIMORE DISTRICT CORPS OF ENGINEERS

BALTIMORE, MARYLAND

21203

(12) 93p.

(11) MARCH 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM INSPECTION REPORT

NAME OF DAM: Licking Creek Dam (Clearview Reservoir)
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Juniata
STREAM: Licking Creek
DATE OF INSPECTION: October 26, 1978

ASSESSMENT

The assessment of Licking Creek Dam is based upon visual observations made at the time of inspection, review of available records and data, hydrologic and hydraulic computations, and past operational performance.

The dam and embankment appeared to be in good condition and well maintained.

The existing spillway and reservoir are capable of passing only 26% of the PMF (Probable Maximum Flood). Based upon criteria established by the Corps of Engineers, the spillway is termed seriously inadequate. If Licking Creek Dam should fail due to overtopping, the hazard to loss of life and property downstream from the dam would be significantly increased from that which would exist just prior to overtopping. As a result of the seriously inadequate spillway, the dam is considered an unsafe non-emergency dam.

The following recommendations and remedial measures should be instituted.

1. Perform additional studies by a registered professional engineer knowledgable in dam design and inspection for modification of the spillway and/or embankment to control the PMF. This study should begin immediately and remedial modifications begun immediately after the study is complete.

2. The low area on the crest should be filled.

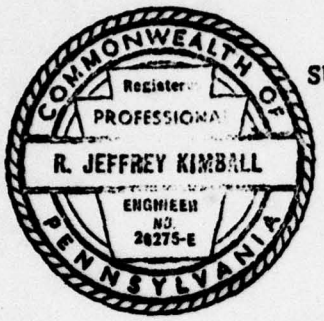
3. Piezometers should be installed in the downstream slope. If the phreatic line is near the downstream slope, the stability of the dam and piping potential should be investigated for high pool conditions.

4. Institute a formal inspection program to be conducted at regular intervals with the authority's engineer.

5. The deteriorating crib apron at the spillway outlet should be repaired to prevent undercutting of the spillway due to large discharges.

6. Institute a plan for rapid closure of the outlet works (30" pipe) at the upstream end in the event the pipe should rupture, creating an emergency condition and for periodic inspection purposes.

7. Institute a formal warning system to warn downstream residents of large spillway discharges or failure of the dam.



SUBMITTED BY: L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS

R Jeffrey Kimball
R. Jeffrey Kimball, P.E.

3-16-79
Date

K. Chuang
Kuang-hwei Chuang, P.E.

23 Apr 79
Date

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

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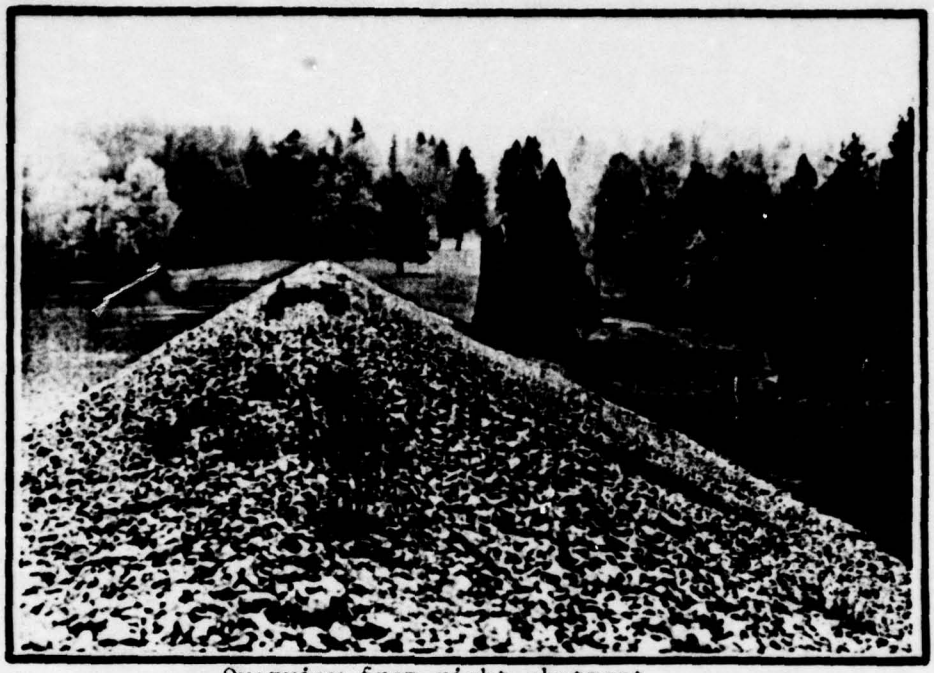
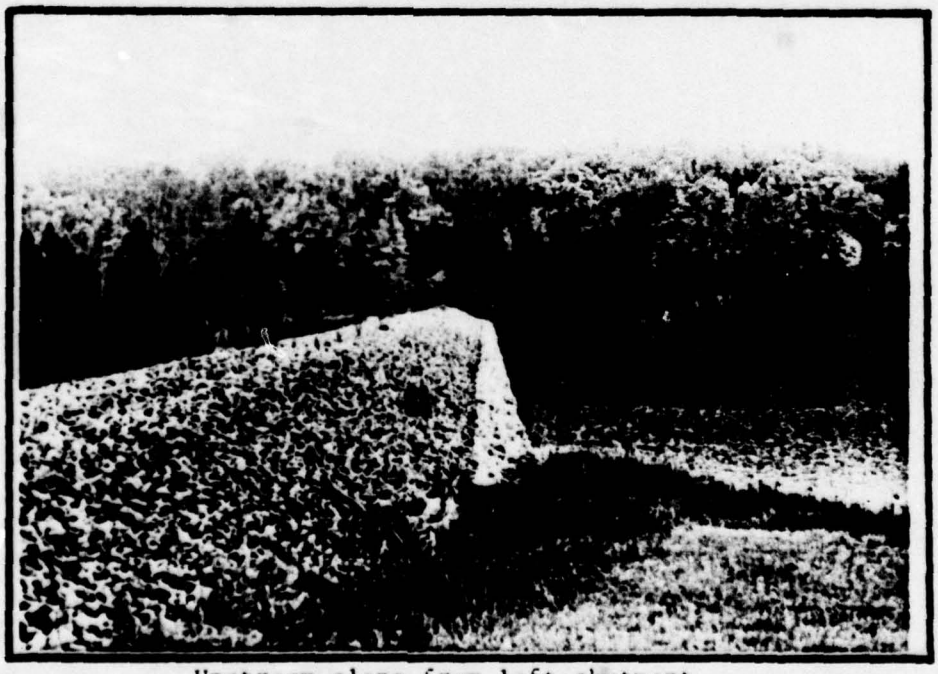


Overview from right abutment.



Upstream slope from left abutment.

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APPENDICES

PHASE I
NATIONAL DAM INSPECTION PROGRAM
LICKING CREEK DAM
NDI I.D. NO. PA 581
DER I.D. NO. 34-1

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Licking Creek Dam is an earthfill dam with a concrete corewall. The embankment is 700 feet long and 26 feet high at the maximum section. The 2 foot thick concrete core wall is reported to have been placed on the upstream side of the dam axis well into bedrock (some 30 feet below streambed) and extends halfway to the top of the dam. Above the concrete wall is an 18 inch thick rubble masonry wall extending to within 4.5 feet of the top of dam. This rubble masonry wall is constructed on the upstream face and also provides protection against wave action. Above the rubble wall is riprap. The construction drawings called for the upstream portion of the embankment to be "selected material placed in layers and rolled" and the downstream "material placed in layers and rolled". The upstream slope is approximately 2.25H:1V and the downstream slope 2H:1V. The downstream slope is completely covered with riprap.

Water is taken from the reservoir by means of a 16 inch cast iron supply line and a 30 inch cast iron blow off line. Flow through these two lines is regulated by a masonry gate house located just below the dam.

The emergency spillway consists of a concrete lined chute with retaining walls and is located on the right abutment. The spillway control section is 100 feet wide. The spillway exit channel is approximately 270 feet long and ends at a timber crib apron.

b. Location. The dam is located on Licking Creek, approximately 5.5 miles west of Mifflin, Juniata County, Pennsylvania. Licking Creek Dam can be located on the Lewistown, U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. Licking Creek Dam is a small size structure (26 feet high, 182 acre-feet).

d. Hazard Classification. Licking Creek Dam is a high hazard dam. Downstream conditions indicate that loss of life is probable should failure of the dam occur (See Section 3.1e).

e. Ownership. Licking Creek Dam is owned by the Mifflintown Municipal Authority. Correspondence should be addressed to:

Mifflintown Municipal Authority
Box 146
9 North Third Street
Mifflintown, PA 17059
717-436-6525

f. Purpose of Dam. Water supply for Mifflintown and Mifflin.

g. Design and Construction History. The dam was designed and constructed in 1907 by the American Pipe Manufacturing Company for the Clearview Water Supply Company. The dam was built to supply water to the Pennsylvania Railroad. Water was taken from the reservoir to Denholm Station, about 6 miles through a 16 inch line to Narrows Station. In 1937 the dam crest was raised approximately four feet to increase the reservoir freeboard. The dam has since been purchased by the Mifflintown Water Authority.

h. Normal Operating Procedures. The reservoir is maintained at the spillway crest when possible with the excess inflow discharging over the spillway. Water for the municipal water system travels through the 16 inch pipe. This 16 inch line always remains open. Water consumption averages 200,000 gallons per day. The 30 inch blow off line is operated on an annual basis.

1.3 Pertinent Data.

a. Drainage Area. 24 square miles

b. Discharge at Dam Site (cfs).

Maximum known flood at dam site - (probably June, 1972)	Unknown
Water supply line (16") at pool elevation	Unknown
Blowoff line (30") low pool outlet at pool elevation	Unknown

Gated spillway capacity at pool elevation	N/A
Gated spillway capacity at maximum pool elevation	N/A
Ungated spillway capacity at maximum pool elevation (elevation 624.0)	8,093
Total spillway capacity at maximum pool elevation	8,093

c. Elevation (U.S.G.S. Datum) (Feet).

Top of dam	624.0
Maximum pool - design surcharge	Unknown
Full flood control pool	N/A
Recreational pool	N/A
Spillway crest	616.0
Upstream portal - 30" blow off line	Unknown
Downstream portal - 30" blow off line	592.7
Streambed at centerline of dam - approximately	598.8
Maximum tailwater	None

d. Reservoir (feet).

Length of maximum pool	3,800
Length of normal pool	1,800
Length of flood control pool	N/A

e. Storage (acre-feet).

Normal pool	182
Flood control pool	N/A
Design surcharge	Unknown
Top of dam	702

f. Reservoir Surface (acres).

Top of dam	76
Maximum pool	76
Flood control pool	N/A
Normal pool	30
Spillway crest	30

g. Dam.

Type	Earthfill
Length	700 feet
Height	26 feet
Top width	8 feet
Side slopes - Downstream	2H:1V
Upstream	2.25H:1V
Zoning	Yes (corewall)
Impervious core	Yes (corewall)
Cutoff	Yes (corewall)
Grout curtain	None

h. Reservoir Drain.

Type	30" CIP
Length	Approximately 240 feet
Closure	Valve in gate house at toe
Access	To downstream end and valve house only
Regulating facilities	Valve in valve house No upstream control

i. Spillway.

Type	Open chute with broad crested weir
Length	100 feet
Crest elevation	616.0
Gates	None
Upstream channel	10 feet approach - horizontal
Downstream channel	270 feet long concrete lined chute

SECTION 2
ENGINEERING DATA

2.1 Design. Review of information in the files of the Commonwealth of Pennsylvania, Department of Environmental Resources (Penn DER) and Mifflintown Municipal Authority files, showed that very little engineering data is available for review of the structure as originally designed. The information available consisted of two original construction drawings and two drawings on the 1927 raising of the dam. No typical sections on the dam are available for review. No calculations or summaries are available on the stability or hydrology and hydraulics. Penn DER files contain permits and inspection reports pertaining to the dam.

2.2 Construction. No information was available on the construction of the dam. One photograph in Penn DER files shows the two pipes lying in the pipe trench.

2.3 Operation. No formal operating records are maintained.

2.4 Evaluation.

a. Availability. Engineering data were provided by the Division of Dam and Encroachments, Bureau of Water Quality Management, Department of Environmental Resources, Commonwealth of Pennsylvania and by the owner, Mifflintown Municipal Authority. Two representatives of the authority accompanied the inspection team and were available for questioning.

b. Adequacy. The type and amount of design data and other engineering information are limited, and the assessment must be based upon the available data, visual inspection, history, and hydrologic analysis.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of Licking Creek Dam was conducted by personnel of L. Robert Kimball and Associates, accompanied by Authority staff on October 26, 1978. The inspection consisted of:

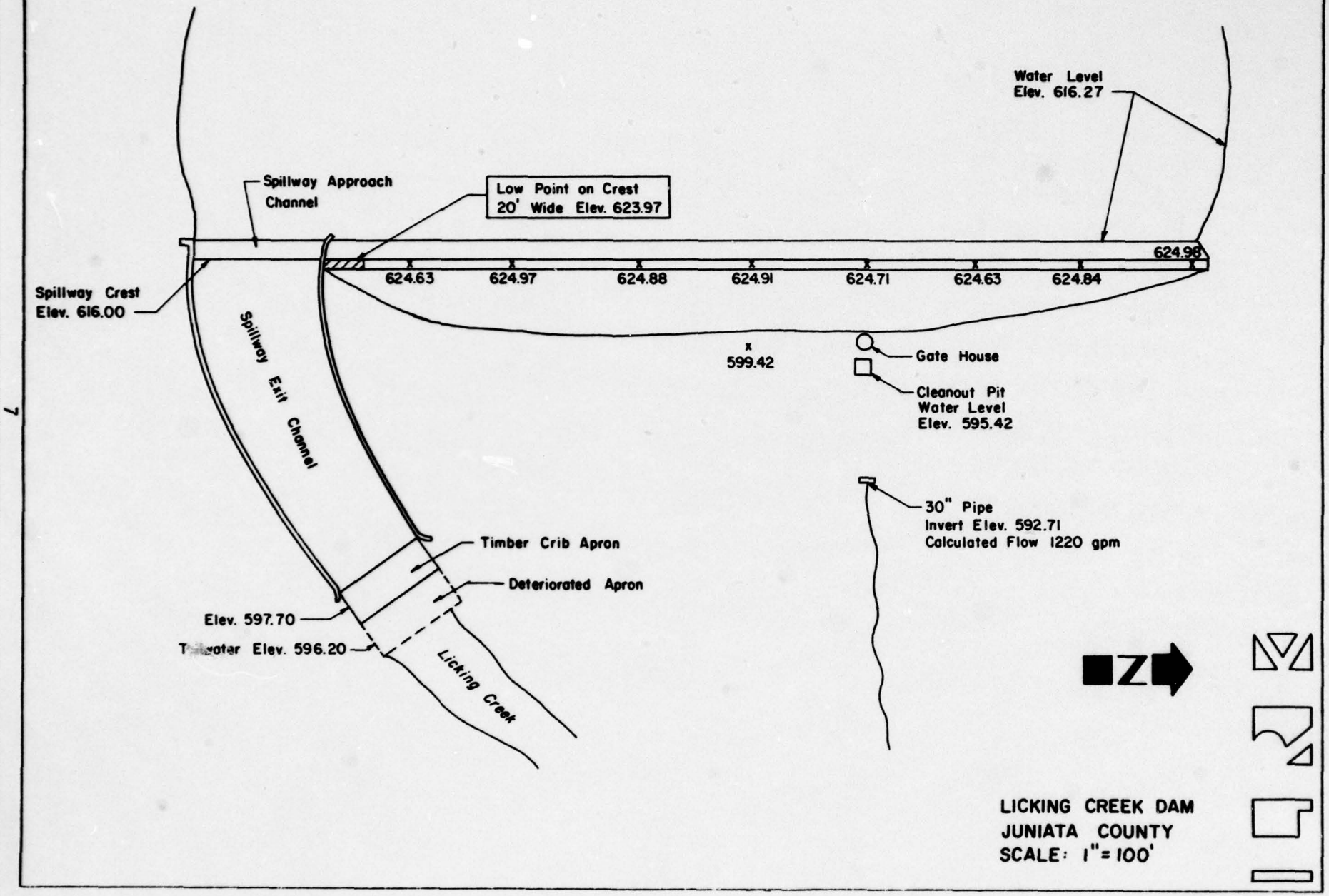
1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portions of any outlet works, and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. The dam appears to closely conform to the few construction drawings available. From a brief survey conducted during the inspection it was noted that a low spot approximately 150 feet long exists on the right abutment adjacent to the spillway wingwall. This low spot gradually increases in depth toward the spillway. The lowest portion is 0.78 feet deep and extends for 20 feet in length (See drawing on page 7).

The embankment appears to be in excellent condition and well maintained. The slope protection on the upstream face consists of masonry paving and is in very good condition. The downstream slope and upper part of the upstream slope are covered with quartzite riprap. This riprap has not disintegrated and is very even over the entire slopes. No erosion gullies were noted. Downstream of the dam the toe area is grassed. This area appears to be mowed often. No wet spots were noted.

c. Appurtenant Structures. The emergency spillway appeared to be in good condition and well maintained. The spillway in the past showed signs of deterioration. These areas have been repaired by concrete patching of cracks and replacing entire slabs or walls. The timber crib apron located at the toe of the spillway exit channel is in need of replacement. Many of the timbers are missing and those in place are rotting. The apron acts as an energy dissipator before entering the natural stream channel.

The gatehouse containing the valves for the 16 inch and 30 inch pipes is in very good condition. The valves were not operated during the inspection but are reportedly operable. It was mentioned that it takes three men to open the 30 inch blowoff line. During the inspection the 30 inch line was partially opened. It was estimated to be passing 2.7 cfs.


Water Level
Elev. 616.27
Spillway Approach
Channel
Low Point on Crest
20' Wide Elev. 623.97
624.98
624.63
624.97
624.88
624.91
624.71
624.63
624.84
Spillway Crest
Elev. 616.00
Spillway Exit Channel
599.42
Gate House
Cleanout Pit
Water Level
Elev. 595.42
30" Pipe
Invert Elev. 592.71
Calculated Flow 1220 gpm
Timber Crib Apron
Deteriorated Apron
Elev. 597.70
Tailwater Elev. 596.20
Licking Creek
N
LICKING CREEK DAM
JUNIATA COUNTY
SCALE: 1"=100'

The cleanout pit below the gatehouse was opened. Several feet of water were present in the pit. It is reported that the pit fills rapidly when water is pumped out of the pit.

d. Reservoir Area. The watershed is almost totally covered with steep to moderately steep woodland. The reservoir slopes are not considered to be susceptible to massive landslides which would affect storage volume of the reservoir or overtopping of the dam by displacing water.

e. Downstream Channel. Licking Creek downstream of the dam has a moderately wide channel before entering Tuscarora Creek. The floodplain supports farmland and pastureland. The first downstream exposure (Martins Crossroads) is approximately .8 mile downstream of the dam. Here the stream splits and goes under two bridges. Three houses and a mobile home are located 8 - 12 feet above the streambed.

3.2 Evaluation. The visual inspection did not reveal any reasons for immediate concern. In general, the embankment and appurtenant structures appear to be in excellent condition and well maintained.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. The reservoir is maintained at as high a level (spillway crest) as possible. The 30 inch blowoff line is always left partially opened. Annually the blowoff line is opened to remove any silt built up in front of the inlet and to grease the valve. The 16 inch water supply line is always left open and the flow through the line is regulated at the filtration plant located several miles downstream.

4.2 Maintenance of the Dam. No planned maintenance schedule is utilized. All maintenance is performed on an as-needed basis. Minor work such as mowing grass is performed by borough staff. Major work is contracted. Maintenance of the dam is considered to be very good.

4.3 Maintenance of Operating Facilities. Maintenance of the operating facilities is performed by borough staff. The 30 inch blowoff line is operated annually. The 16 inch line is reported to be kept open at all times. Maintenance of the operating facilities is considered to be fair.

4.4 Warning System in Effect. There is no formal warning system in effect. No communications equipment is available at the dam and no one is stationed at the dam.

4.5 Evaluation. The operational procedures of the dam and appurtenant structures are considered to be good. The dam is probably accessible by paved roads during major flooding. No warning system is in effect to warn downstream residents of high discharges or failure of the dam.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. No calculations or design data pertaining to hydrology were available.

b. Experience Data. No rainfall runoff, or reservoir level data were available. The spillway reportedly has functioned adequately in the past.

c. Visual Observations. The spillway appeared to be in good condition and well maintained. The timber crib apron located at the spillway discharge is in need of repair.

A low spot was noted on the dam embankment adjacent to the spillway approach wingwall. This area could easily be filled to the top of dam elevation.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway. The PMF is that hypothetical flow induced by the most severe combination of precipitation, infiltration losses, and concentration of runoff at a specific location that is considered reasonably possible for a particular drainage area.

To assist the engineer, and provide a standard for hydrologic analyses, the Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D. A copy of the Users Manual should be obtained by engineers who need more precise definitions of the computer program requirements and methodology.

5.2 Evaluation Assumptions. To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. For the dam breach analysis it was assumed that dam failure would begin when the water level in the reservoir reached elevation 626.0 or two feet over the top of the dam.

2. For the overtopping analysis the top of dam elevation of 624.8 was assumed for the entire length of the crest of 700 feet. Field survey measurements taken during the inspection indicate that the top of dam elevation varies from 624.98 feet to 623.97 feet.

5.3 Summary of Overtopping Analysis. Complete summary sheets from the computer output are presented in the hydrologic appendix.

a. Spillway Adequacy Rating. The spillway design flood (SDF) for Licking Creek Dam is the PMF. The SDF is based on the size and hazard classification of the dam. Based on the following definition provided by the Corps of Engineers, the spillway for this dam is rated as seriously inadequate as a result of our hydrologic analysis.

> Seriously Inadequate - High hazard classification dams not capable of passing 50% of the PMF without failure where there is a significant increase in the hazard potential for loss of life downstream due to overtopping failure.

The spillway and reservoir are capable of controlling approximately 26% of the PMF without overtopping the embankment at elevation 624.0 (low spot). Computer printout of the hydrology is included in Appendix D.

5.4 Summary of Dam Breach Analysis. As the subject dam cannot satisfactorily pass 50% of the PMF without failure (based on our analysis) it was necessary to perform a breach analysis and downstream routing of the flood wave. This analysis determines the degree of increased flooding due to dam failure.

Results of the Dam Breach Analysis indicate that downstream flooding is significantly increased. Therefore, the spillway capacity is rated as seriously inadequate.

The water level in the reservoir at the time of dam failure was assumed to be at 626.0' based on the evaluating engineer's judgement. The 50% PMF was routed through the reservoir and downstream. The results of this analysis indicate that failure due to overtopping will significantly increase downstream potential for loss of life. Detailed results of the flood wave routing are included in Appendix A. In our opinion, failure of the dam will significantly increase downstream flooding.

Note: Future development within the watershed, at the dam, or downstream may change the characteristics and assumptions made for this study and different results are likely. Future development downstream may also greatly increase the potential for loss of life due to failure of the structure.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual inspection did not reveal any signs of immediate instability. The downstream slope of the embankment is rather steep but appeared to be good. The riprap slope cover on the downstream slope may obscure any seepage or wet areas present.

b. Design and Construction Data. No record or design data or stability analysis for the original structure was available for review. No construction data is available which would have an effect on stability.

c. Operating Records. No operating records are available for review.

d. Post-Construction Changes. The embankment was raised four feet and the crest width reduced to eight feet in 1937.

e. Seismic Stability. The dam is located in seismic zone 1. No seismic stability analysis has been performed. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake loading.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The visual observations, review of available information, hydrologic calculations, and past operational performance indicate that Licking Creek Dam's spillway is seriously inadequate. The spillway is capable of only handling approximately 26% of the PMF without overtopping. As a result of the seriously inadequate spillway the dam is considered to be an unsafe non-emergency dam.

No stability analysis has been performed on the original structure. No stability analysis has been conducted on the effect of the four foot increase in height. The downstream slope is rather steep (2H:1V) and there is no internal drainage system. The riprap cover on the downstream slope may obscure any wet areas or seepage zones. The phreatic surface may intercept the downstream slope. To verify the phreatic surface piezometers should be installed.

b. Adequacy of Information. Sufficient data are available to complete a Phase I Dam Inspection Report.

c. Urgency. The recommendations suggested below should be implemented immediately.

d. Necessity for Further Investigations. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 Recommendations/Remedial Measures.

1. Perform additional studies by a registered professional engineer knowledgeable in dam design and inspections for modification of the spillway and/or embankment to control the PMF. This study should begin immediately and remedial modifications begun immediately after the study is complete.

2. The low area on the crest should be filled.

3. Piezometers should be installed in the downstream slope. If the phreatic line is near the downstream slope, the stability of the dam and piping potential should be investigated for high pool conditions.

4. Institute a formal inspection program to be conducted at regular intervals with the authority's engineer.

5. The deteriorating crib apron at the spillway outlet should be repaired to prevent undercutting of the spillway due to large discharges.

6. Institute a plan for rapid closure of the outlet works (30") pipe at the upstream end in the event the pipe should rupture, creating an emergency condition and for periodic inspection purposes.

7. Institute a formal warning system to warn downstream residents of large spillway discharges or failure of the dam.

APPENDIX A

CHECKLIST, VISUAL INSPECTION, PHASE I

CHECK LIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Licking Creek Dam COUNTY Juniata STATE Pennsylvania ID# PA 581

TYPE OF DAM Earthfill HAZARD CATEGORY High

DATE(s) INSPECTION October 26, 1978 WEATHER Cool, rainy TEMPERATURE 50's

POOL ELEVATION AT TIME OF INSPECTION 616.27 M.S.L. TAILWATER AT TIME OF INSPECTION None M.S.L.

INSPECTION PERSONNEL:

R. Jeffrey Kimball - L. Robert Kimball and Associates

James T. Hockensmith - L. Robert Kimball and Associates

Larry Woodling - Mifflintown Municipal Authority

Stan Worrall - Mifflintown Municipal Authority

James T. Hockensmith RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None noted.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal appears alright. Low spot toward right abutment. 150' long - up to .78 low.	
RIPRAP FAILURES	None noted.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	None. Several cedars at toe around gate-house.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Appears to be good.	
ANY NOTICEABLE SEEPAGE	None noted.	
STAFF GAUGE AND RECORDER	None.	
DRAINS	None.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	N/A	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N/A	
DRAINS	N/A	
WATER PASSAGES	N/A	
FOUNDATION	N/A	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N/A	
STRUCTURAL CRACKING	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT	N/A	
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	N/A	
STAFF GAUGE OR RECORDER	N/A	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Complete examination of the two lines (16 and 30 inch) not possible. Only portion of lines in clean out pit at toe visible.	
INTAKE STRUCTURE	Not visible.	
OUTLET STRUCTURE	Masonry endwall for 30 inch line all right.	
OUTLET CHANNEL	Appears all right.	
EMERGENCY GATE	None.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	100' long broad crested weir. Condition good.	
APPROACH CHANNEL	10'long. Good condition.	
DISCHARGE CHANNEL	Concrete chute. Well maintained. Timber apron at end needs replaced.	
BRIDGE AND PIERS	None.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Natural stream. Moderately wide channel. Farming and pastureland.	
SLOPES	Very gentle.	
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 8 homes (32 people).	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderately steep. Appear stable.	
SEDIMENTATION	Does not appear to be excessive.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER		

APPENDIX B

CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Licking Creek Dam

ID# PA 581

ITEM	REMARKS
AS-BUILT DRAWINGS	None available.
REGIONAL VICINITY MAP	None available.
CONSTRUCTION HISTORY	None available.
TYPICAL SECTIONS OF DAM	None available.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	None available.
RAINFALL/RESERVOIR RECORDS	None available.

ITEM	REMARKS
DESIGN REPORTS	None available.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Test borings were made along axis of dam - logs not available.
POST-CONSTRUCTION SURVEYS OF DAM	None.
BORROW SOURCES	Unknown.

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Embankment raised 4 feet (1937) - 2 drawings in Penn DER files.
HIGH POOL RECORDS	None available.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None available.
MAINTENANCE OPERATION RECORDS	None available.

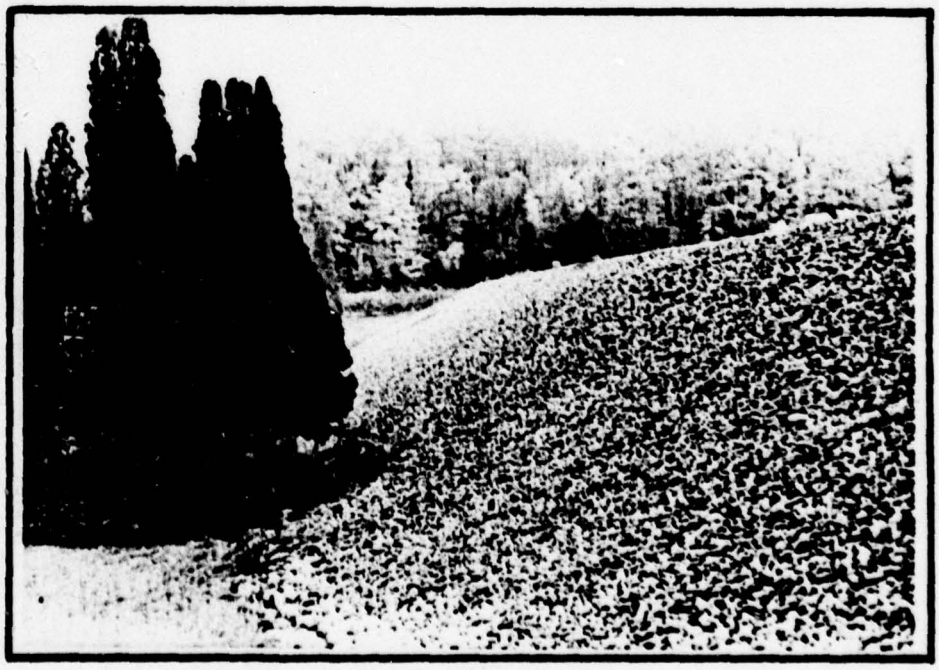
ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	One construction drawing (1906) Penn DER files.
OPERATING EQUIPMENT PLANS & DETAILS	None available.

APPENDIX C

PHOTOGRAPHS

Photograph No. 1

Downstream slope from right abutment toe.



Photograph No. 2

Downstream slope from left abutment toe.

Photograph No. 3

Spillway entrance and control section at right abutment.

Photograph No. 4

Looking down spillway exit channel.

Photograph No. 5

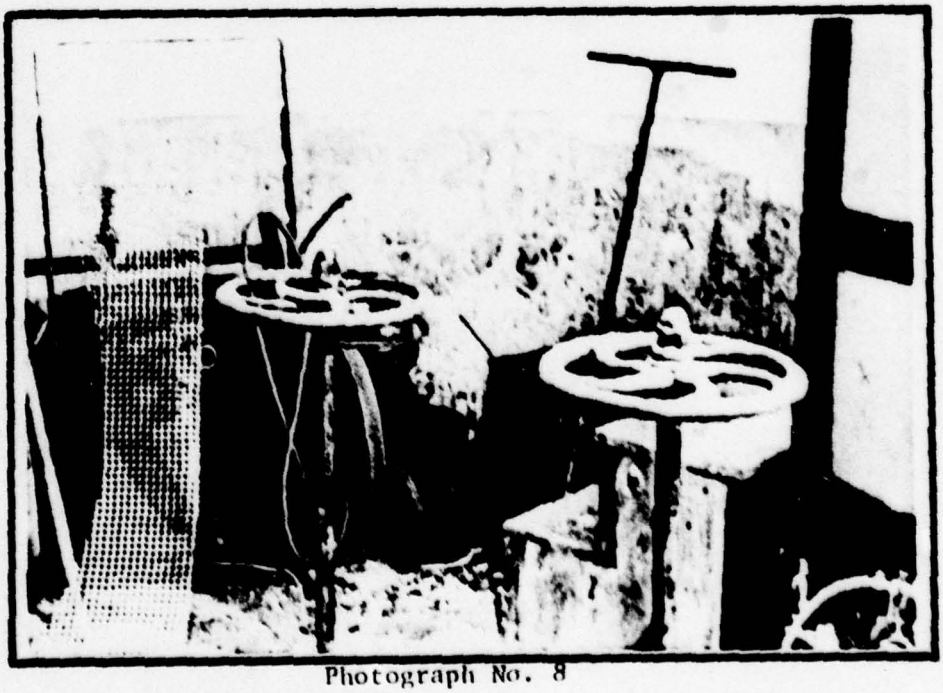
Looking down spillway exit channel at stilling basin and downstream channel.

Photograph No. 6

Timber stilling basin.

Photograph No. 7

Gatehouse structure at downstream toe.



Photograph No. 8

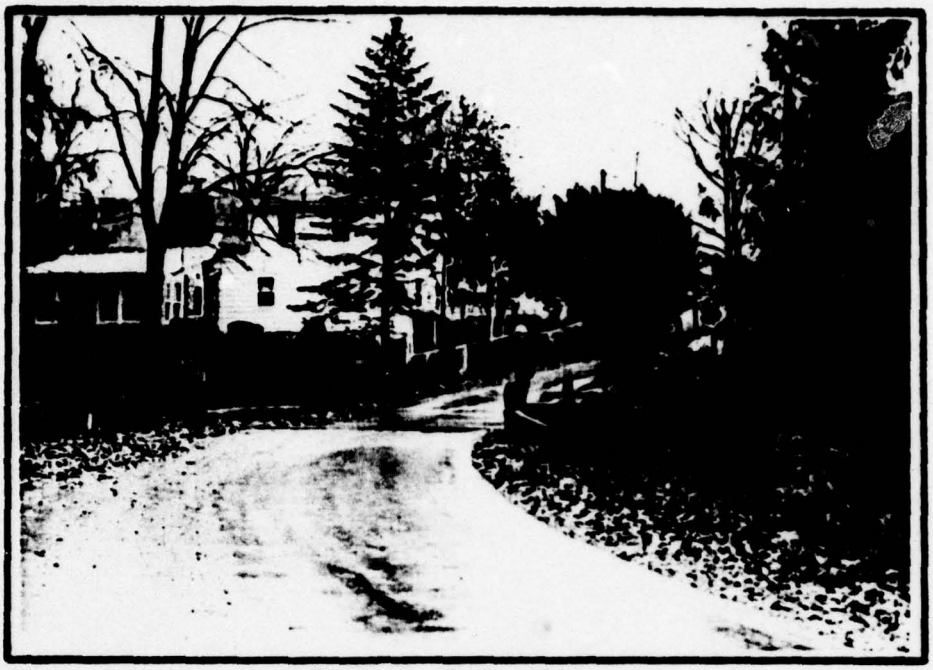
Manual control valves in gatehouse.

Photograph No. 9

Discharge endwall for reservoir drain pipe.

Photograph No. 10

Slope paving on upstream face.



Photograph No. 11

First dwelling downstream.

Photograph No. 12

Second dwelling downstream.

Photograph No. 13

Zooks Dam breached by 1972 flood.

Photograph No. 14

Looking upstream from Zooks Dam.

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation. The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Reports No. 40 prepared by the National Weather Service.

The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

Parameter	Definition	Where Obtained
C_t	Coefficient representing variations of watershed slope and storage	From Corps of Engineers*
L	Length of main stream channel miles	From U.S.G.S. 7.5 minute topographic
L_{ca}	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic
C_p	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

3. Routing. Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping. Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach and Downstream Routing. The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 24 sq. miles - steep woodland

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 616.0 (182 Ac-ft)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 624.0

SPILLWAY CREST:

a. Elevation 616.0
b. Type Broad crested weir
c. Width Approximately 10'
d. Length 100'
e. Location Spillover Right abutment
f. Number and Type of Gates None

OUTLET WORKS:

a. Type 16" cast iron supply line and 30" blowoff line
b. Location Through center of dam
c. Entrance inverts Unknown
d. Exit inverts 30" - 592.71
e. Emergency draindown facilities 30" pipe

HYDROMETEOROLOGICAL GAUGES:

a. Type None
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME Licking Creek Dam
I.D. NUMBER PA. 34-1
SHEET NO. 1 OF 3
BY KHC DATE 1-30-79

Licking Creek Dam

Drainage Area. $A = 24.0$ sq. mi (from U.S.G.S. Quad)

Unit Hydrograph Parameters:

Damsite located in zone 21, Susquehanna River Basin
From COE, Baltmore Dist. regional study

$C_p = 0.55$, $C_t = 1.5$

$L = 13.3$ mi., $L_{ca} = 6.8$ mi. (from U.S.G.S. Quad)

$\therefore t_p = C_t (L \cdot L_{ca})^{0.3} = 1.5 (13.3 \times 6.8)^{0.3}$

$t_p = 5.79$ (hrs.)

Loss Rate & Base Flow Parameters:

Recommended by COE

STRTL = 1 inch
CNSTL = 0.05 in/hr.
STRTQ = 1.5 cfs/mi^2
QRCSN = 0.05 (5% of Peak Flow)
RTIOR = 2.0

Probable Maximum Storm: from HR #40

PMP Index Rainfall — 22.2"

R6 = 108%, R12 = 118%, R24 = 127%,
R48 = 134%, R72 = 137%

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME Licking Creek Dam
I.D. NUMBER PA. 34-1
SHEET NO. 2 OF 3
BY KHC DATE 1-30-79

Elevation – Area – Capacity Relationship:

at spillway crest El. 616.0', Initial Storage = 182 (AF)

from U.S.G.S. Quad, El. 616.0' Surface Area = 30 (Acres)

El. 620.0 A = 60 (Acres)

El. 640.0 A = 101 (Acres)

by Conic Method, $H = \frac{3V}{A} = \frac{3(182)}{30} = 18.2'$

Elev. of zero capacity = 616.0 - 18.2
= 597.8'

Elevation (ft)	597.8	616	618	620	622	624	626	628	630
Area (Acres)	0	30	50	60	68	74	78	83	86

Discharge – Rating Curves:

Discharge Rating Curves were determined with HEC-1 based on the following parameters:

$$Q = CLH^{1.5}$$

	L, Weir length	C
Spillway	100'	3.1 (broad-crested weir)
Dam	700'	3.05

Spillway crest El. = 616.0'
Top of Dam El. = 624.8'

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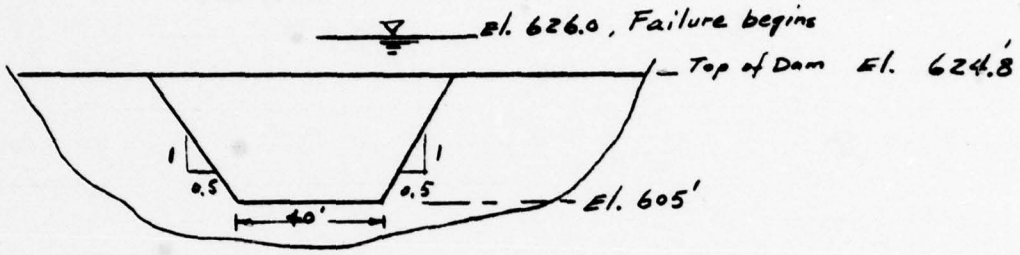
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME Licking Creek Dam
I.D. NUMBER PA. 34-1
SHEET NO. 3 OF 3
BY KHC DATE 1-30-79

Dam Breach Parameters:



Ratio of PMF = 0.5
Breach width — BRWID = 40'
Side slope of breach Z = 0.5
Failure time TFAIL = 2 hrs.,
Elevation. Failure begins, FAILEL = 626.0'

Channel Routing

Channel cross sections obtained from U.S.G.S. Quad

Channel Manning's n, QN(2) = .05

Overbank Manning's n, QN(1) = QN(3) = .06

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  25 SEP 78
**********
    1          A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2          A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LICKING CREEK DAM
    3          A3       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR  I.D. NO 34-1
    4          B   288       0       15        0        0        0        0        0       -4        0
    5          B1    5
    6          J     1       5        1
    7          J1  0.2     0.3     0.4      0.5        1
    8          K     0       1                                            1
    9          K1       INFLOW TO RESERVOIR
   10          M     1       1     24.                24.                                    1
   11          P           22.2     108      118      127      134      137
   12          I                                                      1.0     0.05
   13          W  5.79    0.55
   14          X  -1.5     -.05     2.0
   15          K     1       2                                            1
   16          K1       ROUTE THRU RESERVOIR
   17          Y                                        1        1
   18          Y1    1                                                  182.3
   19          $A   0.      30.      50.      60.      68.      74.      78.      83.      86.      90.
   20          $A  93.      96.      99.     101.
   21          $E 597.8    616.     618.     620.     622.     624.     626.     628.     630.     632.
   22          $E 634.     636.     638.     640.
   23          $S 616.     100.       3.1      1.5
   24          $D 624.8     3.05      1.5     700.
   25          K    99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
END OF NETWORK	

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 25 SEP 78
****

RUN DATE 79/01/23.
TIME 17.56.26.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LICKING CREEK DAM
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR I.D. NO 34-1

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1
RTIOS= .20 .30 .40 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	IRSDA	IRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	24.00	0.00	24.00	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.20	108.00	118.00	127.00	134.00	137.00	0.00

IRSPC COMPUTED BY THE PROGRAM IS .829

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 5.79 CP= .55 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES. LAG= 5.77 HOURS. CP= .55 VOL= .96

13.	50.	103.	167.	240.	319.	404.	493.	587.	684.
784.	886.	989.	1086.	1173.	1252.	1320.	1380.	1429.	1469.
1498.	1516.	1522.	1512.	1479.	1429.	1377.	1328.	1280.	1234.
1189.	1146.	1105.	1065.	1026.	989.	953.	919.	886.	854.
823.	793.	765.	737.	710.	685.	660.	636.	613.	591.
570.	549.	529.	510.	492.	474.	457.	440.	424.	409.
394.	380.	366.	353.	340.	328.	316.	305.	294.	283.
273.	263.	254.	244.	236.	227.	219.	211.	203.	196.
189.	182.	176.	169.	163.	157.	151.	146.	141.	136.
131.	126.	121.	117.	113.	109.	105.	101.	97.	94.

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.20	22.48	2.72	1337445.
										(640.)(	571.)(	69.)(	37872.22)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THRU RESERVOIR

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

OLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	182.	0

SURFACE AREA=	0.	30.	50.	60.	68.	76.	78.	83.	86.	90.
	93.	96.	99.	101.						
CAPACITY=	0.	182.	261.	371.	499.	641.	793.	956.	1123.	1299.
	1482.	1671.	1866.	2066.						
ELEVATION=	598.	616.	618.	620.	622.	624.	626.	628.	630.	632.
	634.	636.	638.	640.						

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
616.0	100.0	3.1	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
624.8	3.1	1.5	700.

PEAK OUTFLOW IS 5440. AT TIME 45.75 HOURS

PEAK OUTFLOW IS 8195. AT TIME 45.75 HOURS

PEAK OUTFLOW IS 11093. AT TIME 45.25 HOURS

PEAK OUTFLOW IS 13875. AT TIME 45.25 HOURS

PEAK OUTFLOW IS 27765. AT TIME 45.25 HOURS

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .30	RATIO 3 .40	RATIO 4 .50	RATIO 5 1.00
HYDROGRAPH AT	1	24.00	1	5556.	8334.	11112.	13890.	27781.
		(62.16)		(157.33)(	236.00)(	314.67)(	393.33)(	786.67)(
ROUTED TO	2	24.00	1	5440.	8195.	11093.	13875.	27765.
		(62.16)		(154.05)(	232.06)(	314.11)(	392.88)(	786.20)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	616.01	616.00	626.80
STORAGE	182.	182.	701.
OUTFLOW	0.	0.	8093.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	622.75	0.00	551.	5440.	0.00	45.75	0.00
.30	624.85	.05	705.	8195.	1.00	45.75	0.00
.40	625.68	.88	768.	11093.	5.75	45.25	0.00
.50	626.25	1.45	812.	13875.	8.00	45.25	0.00
1.00	628.35	3.55	989.	27765.	14.75	45.25	0.00

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  25 SEP 78
**********************************
    1          A1       RATIO OF PMF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM
    2          A2       DOWNSTREAM CONDITION DUE TO OVERTOP  LICKING CREEK DAM PA 34-1
    3          A3       PLAN 1 ASSUMES BREACH. PLAN 2 ASSUMES NO BREACH
    4          B    288       0      15       0       0       0       0       0      -4       0
    5          B1     5
    6          J      2       1       1
    7          J1   0.5
    8          K      0       1                                               1
    9          K1        INFLOW TO RESERVOIR
   10          M      1       1      24.                     24.                                1
   11          P                   22.2     108     118     127     134     137
   12          T                                                           1.0    0.05
   13          W    5.79    0.55
   14          X    -1.5    -.05     2.0
   15          K      1       2                                               1
   16          K1        ROUTE THRU RESERVOIR
   17          Y                                       1       1
   18          Y1     1                                                   182.3
   19          $A    0.      30.     50.     60.     68.     74.     78.     83.     86.     90.
   20          $A   93.      96.     99.    101.
   21          $E 597.8     616.    618.    620.    622.    624.    626.    628.    630.    632.
   22          $E 634.      636.    638.    640.
   23          $S 616.      100.      3.1     1.5
   24          $D 624.8       3.05    1.5   700.
   25          $B   40.   .5        605.    2.      616.    626.
   26          $B   40.     .5      605.    2.      616.    628.
   27          K      1       3                                               1
   28          K1        CHANNEL ROUTING -MOD PULS  REACH 2-3
   29          Y                                       1       1
   30          Y1     1
   31          Y6   .06    .05     .06      560     620    4600   .0057
   32          Y7     0     620      300     600     600     580     900     560 910.    560.
```

DTIC

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33              Y7  1150     580    1400     600    1550     620                                1
34              K     1       4                                                    1
35              K1       CHANNEL ROUTING -MOD PULS  REACH 3-4
36              Y                                      1       1
37              Y1    1
38              Y6  .06    .05     .06        504     550   11000   .0050
39              Y7    0     560     150        540     650     520     800     504   810.     504.
40              Y7 1200     520    1700        540    2800     560
41              K     1       5                                                    1
42              K1       CHANNEL ROUTING -MOD PULS  REACH 4-5
43              Y                                      1       1
46              Y1    1
45              Y6  .06    .05     .06        472     510    7000   .0046
46              Y7    0     520     150        500     750     480     800     472   810.     472.
47              Y7  850     480    1150        500    1350     520
48              K    99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
ROUTE HYDROGRAPH TO	3
ROUTE HYDROGRAPH TO	4
ROUTE HYDROGRAPH TO	5
END OF NETWORK	

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 25 SEP 78
****

RUN DATE 79/01/23.
TIME 17.56.18.

RATIO OF PMF ROUTED THROUGH THE RESERVOIR AND DOWNSTREAM
DOWNSTREAM CONDITION DUE TO OVERTOP LICKING CREEK DAM PA 34-1.
PLAN 1 ASSUMES BREACH. PLAN 2 ASSUMES NO BREACH

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 2 NRTIO= 1 LRTIO= 1

RTIOS= .50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	IRSDA	IRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	24.00	0.00	24.00	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.20	108.00	118.00	127.00	134.00	137.00	0.00

IRSPC COMPUTED BY THE PROGRAM IS .829

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 5.79 CP= .55 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 5.77 HOURS, CP= .55 VOL= .96

13.	50.	103.	167.	240.	319.	404.	493.	587.	684.
784.	886.	989.	1086.	1173.	1252.	1320.	1380.	1429.	1469.
1498.	1516.	1522.	1512.	1479.	1429.	1377.	1328.	1280.	1234.
1189.	1146.	1105.	1065.	1026.	989.	953.	919.	886.	854.
823.	793.	765.	737.	710.	685.	660.	636.	613.	591.
570.	549.	529.	510.	492.	474.	457.	440.	424.	409.
394.	380.	366.	353.	340.	328.	316.	305.	294.	283.
273.	263.	254.	244.	236.	227.	219.	211.	203.	196.
189.	182.	176.	169.	163.	157.	151.	146.	141.	136.
131.	126.	121.	117.	113.	109.	105.	101.	97.	94.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.20	22.48	2.72	1337445.
										(640.)(571.)(69.)(37872.22)			

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THRU RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	182.	0

SURFACE AREA=	0.	30.	50.	60.	68.	74.	78.	83.	86.	90.
	93.	96.	99.	101.						
CAPACITY=	0.	182.	261.	371.	499.	641.	793.	954.	1123.	1299.
	1482.	1671.	1866.	2066.						
ELEVATION=	598.	616.	618.	620.	622.	624.	626.	628.	630.	632.
	636.	636.	638.	640.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
616.0	100.0	3.1	1.5	0.0	0.0	0.0	0.0

DAM DATA

IOPEL	COOD	EXPD	DAMWID
624.8	3.1	1.5	700.

DAM BREACH DATA

BRWID	Z	ELBM	TEAIL	WSEL	FAILEL
40.	.50	605.00	2.00	616.00	626.00

BEGIN DAM FAILURE AT 44.00 HOURS

PEAK OUTFLOW IS 16895. AT TIME 46.00 HOURS

OVN

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
60.	.50	605.00	2.00	616.00	628.00

PEAK OUTFLOW IS 13875. AT TIME 45.25 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

CHANNEL ROUTING -MOD PULS REACH 2-3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELMVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	560.0	620.0	4600.	.00570

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 620.00 300.00 600.00 600.00 580.00 900.00 560.00 910.00 560.00
1150.00 580.00 1400.00 600.00 1550.00 620.00

STORAGE	0.00	17.55	63.56	137.95	240.81	372.09	531.81	720.08	937.28
1183.44	1458.56	1762.64	2095.68	2457.38	2843.96	3254.22	3688.18	4145.84	4627.19
5132.23									
OUTFLOW	0.00	541.04	3015.02	8481.40	17828.85	31851.95	51281.99	80930.21	119674.09
166081.15	220625.13	283747.47	355873.45	437709.93	529786.89	631705.36	743710.70	866057.52	999005.54
142817.15									
STAGE	560.00	563.16	566.32	569.47	572.63	575.79	578.95	582.11	585.26
588.42	591.58	594.74	597.89	601.05	604.21	607.37	610.53	613.68	616.84
620.00									
FLOW	0.00	541.04	3015.02	8481.40	17828.85	31851.95	51281.99	80930.21	119674.09
166081.15	220625.13	283747.47	355873.45	437709.93	529786.89	631705.36	743710.70	866057.52	999005.54
142817.15									

MAXIMUM STAGE IS 572.3

MAXIMUM STAGE IS 571.3

########## ########## ########## ########## ##########

HYDROGRAPH ROUTING

CHANNEL ROUTING,=MOD PULS REACH 3=A

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO

4	1	0	0	0	0	1	0	0	

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	504.0	550.0	11000.	.00500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 560.00 150.00 540.00 450.00 520.00 800.00 504.00 810.00 504.00
1200.00 520.00 1700.00 540.00 2800.00 560.00

STORAGE	0.00	40.34	149.14	326.40	572.12	886.30	1268.93	1719.31	2230.62
2801.13									
	3430.85	4119.77	4867.90	5675.24	6541.79	7467.83	8453.78	9502.25	10763.23
12046.72									
OUTFLOW	0.00	402.76	2306.02	6556.43	13853.61	24833.69	40076.27	62139.19	92768.67
129247.02									
	171859.28	220870.18	276537.75	339116.39	408857.65	485638.00	568432.04	660503.30	762114.44
873628.22									
STAGE	504.00	506.42	508.84	511.26	513.68	516.11	518.53	520.95	523.37

525.79									
	528.21	530.63	533.05	535.47	537.89	540.32	542.74	545.16	547.58
550.00									
FLOW	0.00	402.76	2306.02	6554.43	13853.61	24833.69	40074.27	62139.19	92768.67
129247.02									
	171859.28	220870.18	276537.75	339116.39	408857.65	485638.00	568432.04	660503.30	762114.44
873628.22									

MAXIMUM STAGE IS 514.2

MAXIMUM STAGE IS 513.7

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

CHANNEL ROUTING -MOD PULS REACH 4-5

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0500	.0600	472.0	510.0	7000.	.044460

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 520.00 150.00 500.00 750.00 480.00 800.00 472.00 810.00 472.00
850.00 480.00 1150.00 500.00 1350.00 520.00

STORAGE	0.00	6.83	20.89	42.18	70.71	117.31	192.84	297.29	430.67
592.98									
	784.21	1004.36	1253.44	1531.45	1838.38	2165.40	2503.67	2853.19	3213.96
3585.97									
OUTFLOW	0.00	101.97	462.23	1185.68	2365.43	4568.43	7911.32	12756.46	19407.24
28137.25									
	39200.31	52835.55	69270.55	88723.40	111404.17	140249.47	172321.93	207596.62	246063.58
287723.68									
STAGE	472.00	474.00	476.00	478.00	480.00	482.00	484.00	486.00	488.00
490.00									
	492.00	494.00	496.00	498.00	500.00	502.00	504.00	506.00	508.00
510.00									
FLOW	0.00	101.97	462.23	1185.68	2365.43	4568.43	7911.32	12756.46	19407.24
28137.25									
	39200.31	52835.55	69270.55	88723.40	111404.17	140249.47	172321.93	207596.62	246063.58
287723.68									

MAXIMUM STAGE IS 487.0

MAXIMUM STAGE IS 486.3

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS 1 .50
HYDROGRAPH AT	1	24.00	1	13890.
		(62.16)		(393.33)(
			2	13890.
				(393.33)(
ROUTED TO	2	24.00	1	16895.
		(62.16)		(478.62)(
			2	13875.
				(392.88)(
ROUTED TO	3	24.00	1	16716.
		(62.16)		(473.33)(
			2	13859.
				(392.34)(
ROUTED TO	4	24.00	1	16199.
		(62.16)		(458.71)(
			2	13761.
				(389.68)(
ROUTED TO	5	24.00	1	15950.
		(62.16)		(451.66)(
			2	13725.
				(388.64)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	616.00	616.00	624.80
STORAGE	182.	182.	701.
OUTFLOW	0.	0.	8093.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	626.07	1.27	799.	16889.	3.17	46.00	46.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	616.00	616.00	624.80
STORAGE	182.	182.	701.
OUTFLOW	0.	0.	8093.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	626.25	1.45	812.	13875.	8.00	45.25	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	16716.	572.3	46.00

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	13895.	571.3	45.50

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	16199.	516.2	46.25

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	13761.	513.7	45.75

PLAN 1 STATION 5

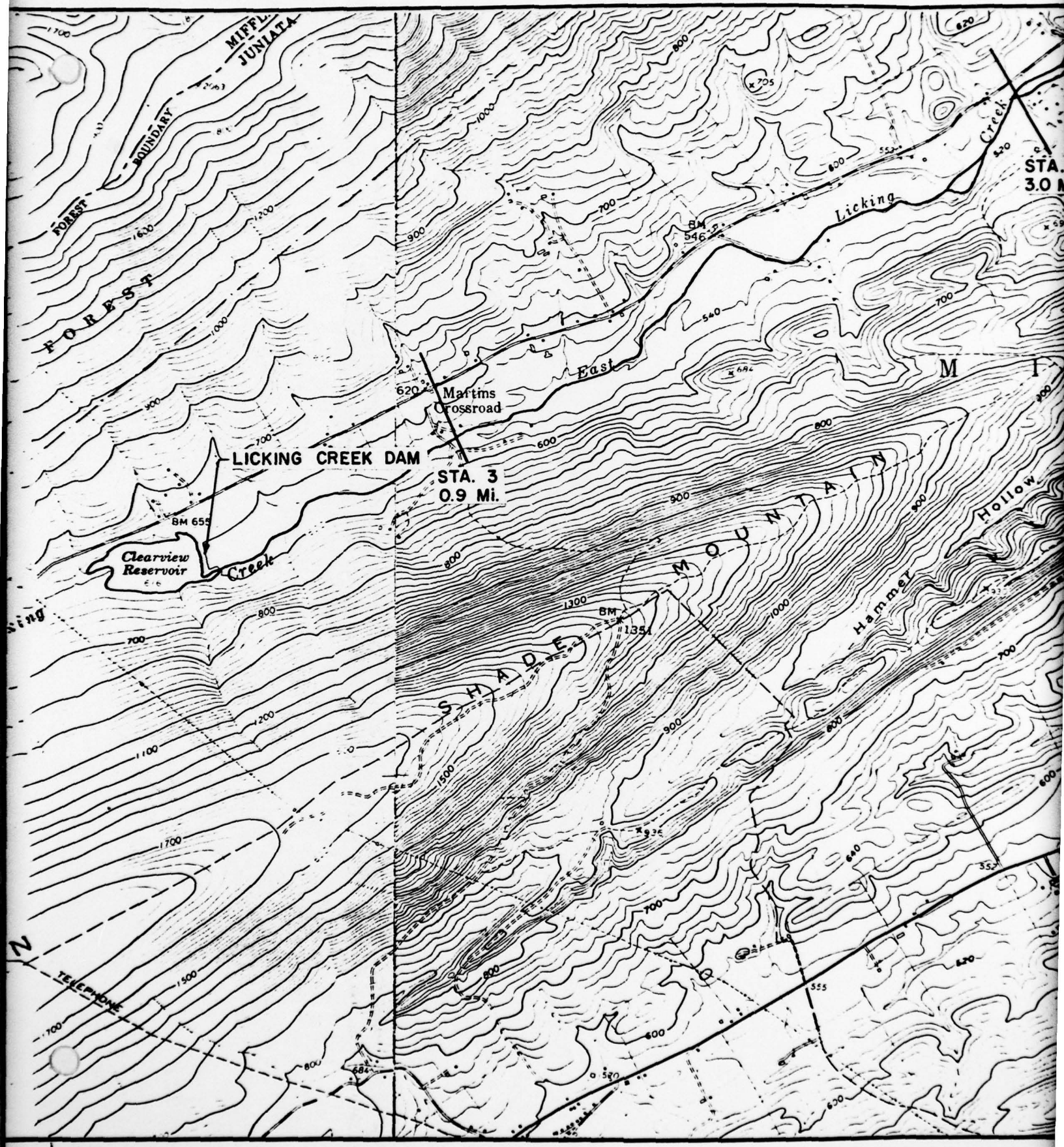
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	15950.	487.0	46.50

PLAN 2 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	13775.	486.3	46.00

APPENDIX E

DRAWINGS


MIFFL.
JUNIATA
BOUNDARY
FOREST
FOREST
1700
1600
1200
1000
900
700
620
Martins
Crossroad
East
Licking
Creek
STA.
3.0 M
BM
546
540
700
LICKING CREEK DAM
STA. 3
0.9 Mi.
BM 655
Clearview
Reservoir
Creek
800
700
1200
1100
1500
1700
1300
BM
1351
SHADE
MOUNTAIN
Hammer
Hollow
1000
900
600
555
640
TELEPHONE
684
530

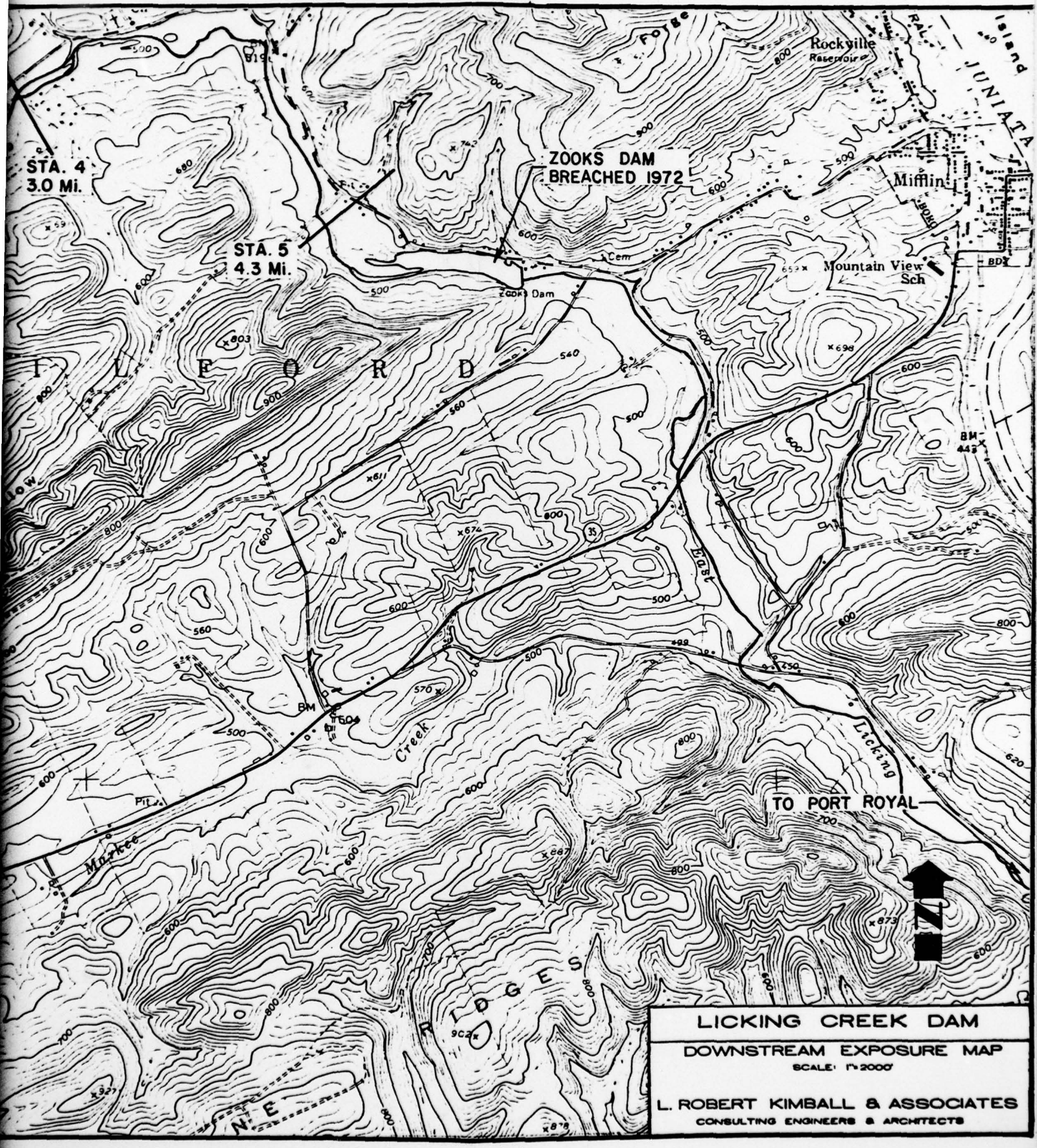
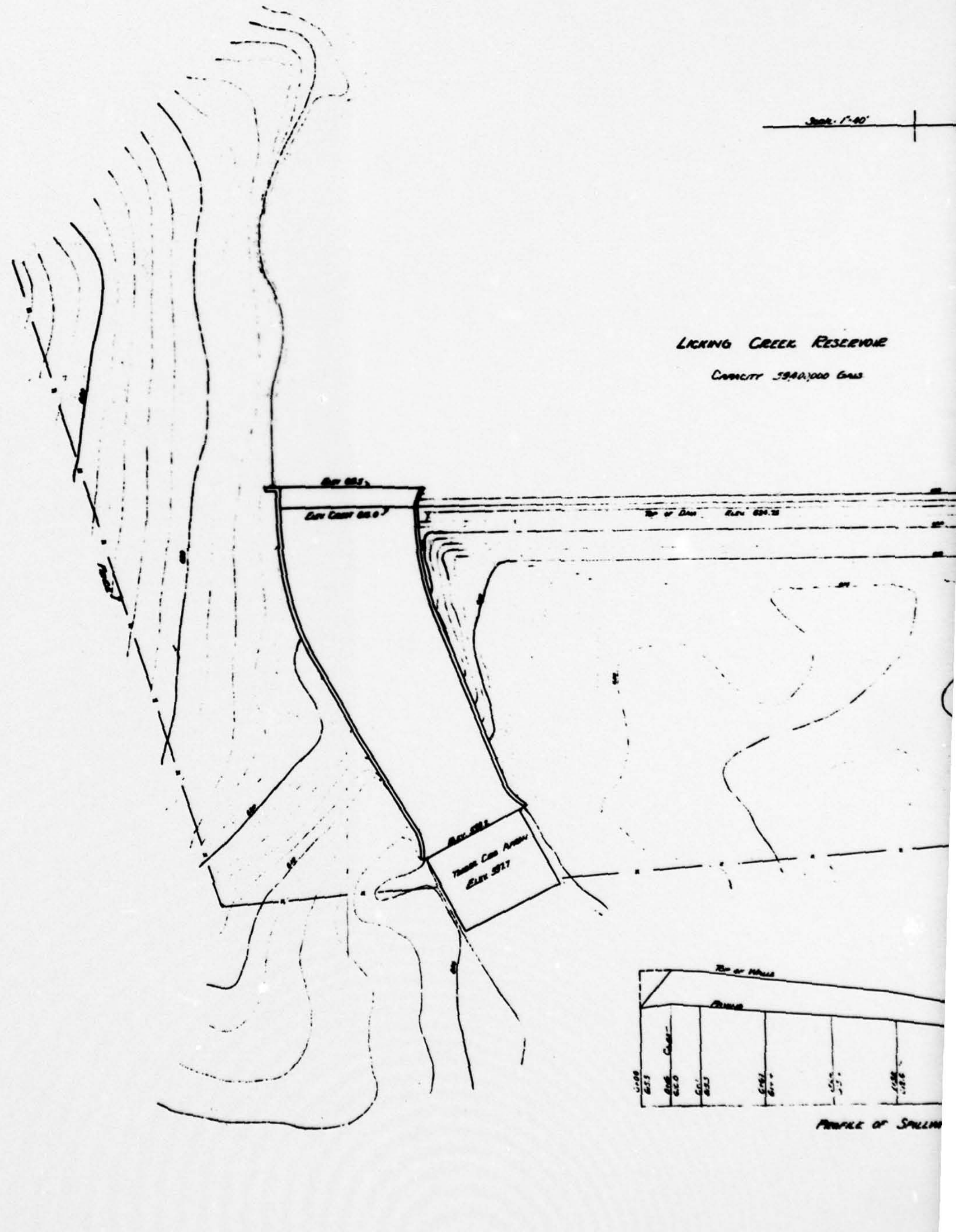
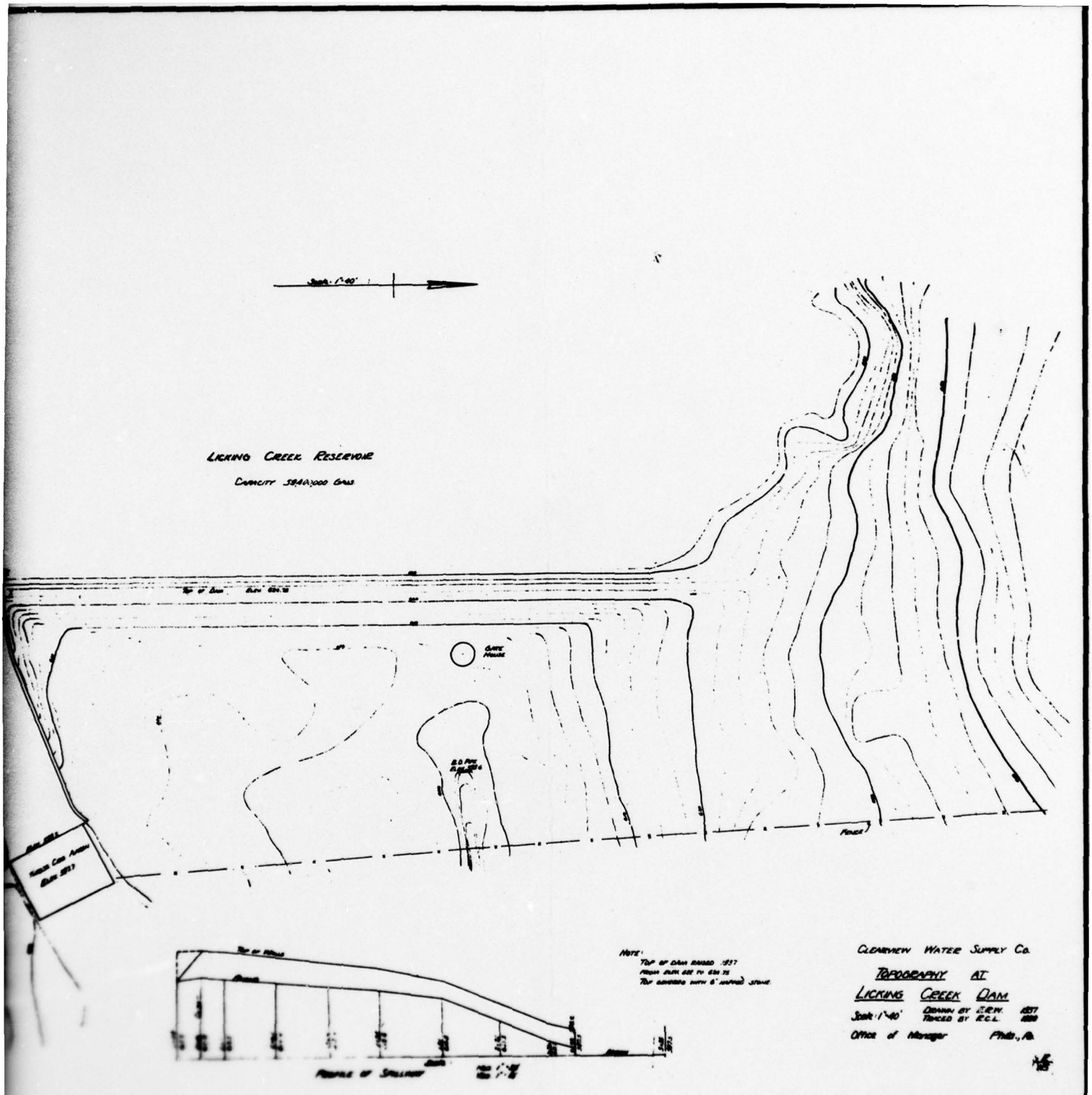
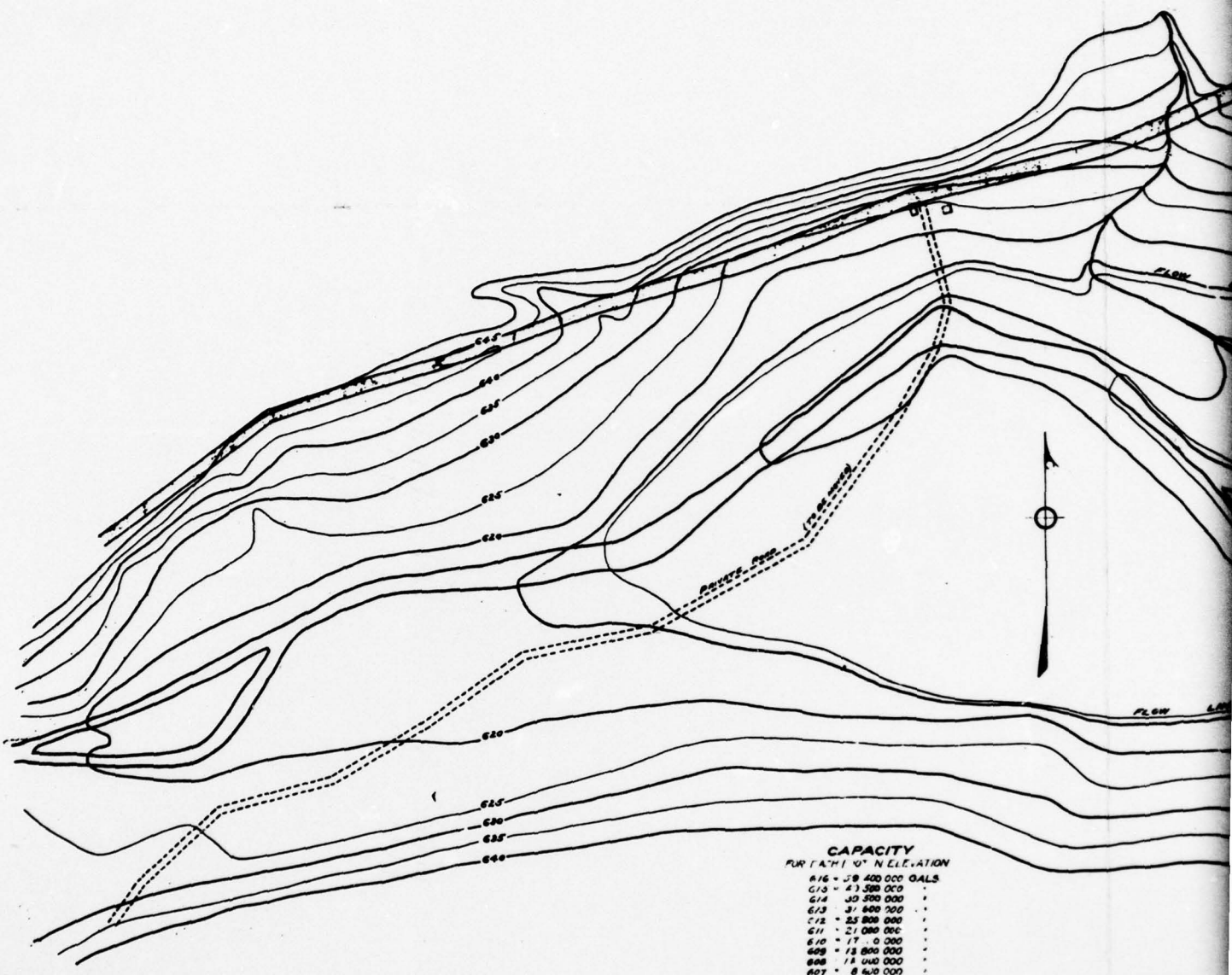

STA. 4
3.0 Mi.
STA. 5
4.3 Mi.
ZOOKS DAM
BREACHED 1972
Rockville
Reservoir
Forge
Island
JUNIATA
Mifflin
Mountain View
Sch
Zooks Dam
Cem
ILFORD
East
Licking
Creek
Markee
Pit
BM
TO PORT ROYAL
RIDGES
NE
LICKING CREEK DAM
DOWNSTREAM EXPOSURE MAP
SCALE: 1"=2000'
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

FIGURE 1


Scale: 1"=40'
LICKING CREEK RESERVOIR
CAPACITY 5940,000 GALS


Scale: 1"=40'
LICKING CREEK RESERVOIR
CAPACITY 3840,000 GALS
Top of Dam
Gate House
B.O. Pipe
Fence
Top of Fillings
Profile of Spillway
NOTE:
Top of Dam raised 1917
From Elev. 681.70 to Elev. 70
Top covered with 6" Macadam Stone
CLEARVIEW WATER SUPPLY CO.
TOPOGRAPHY AT
LICKING CREEK DAM
Scale: 1"=40'
Drawn by C.R.W. 1937
Traced by R.C.L. 1939
Office of Manager
Phila., Pa.

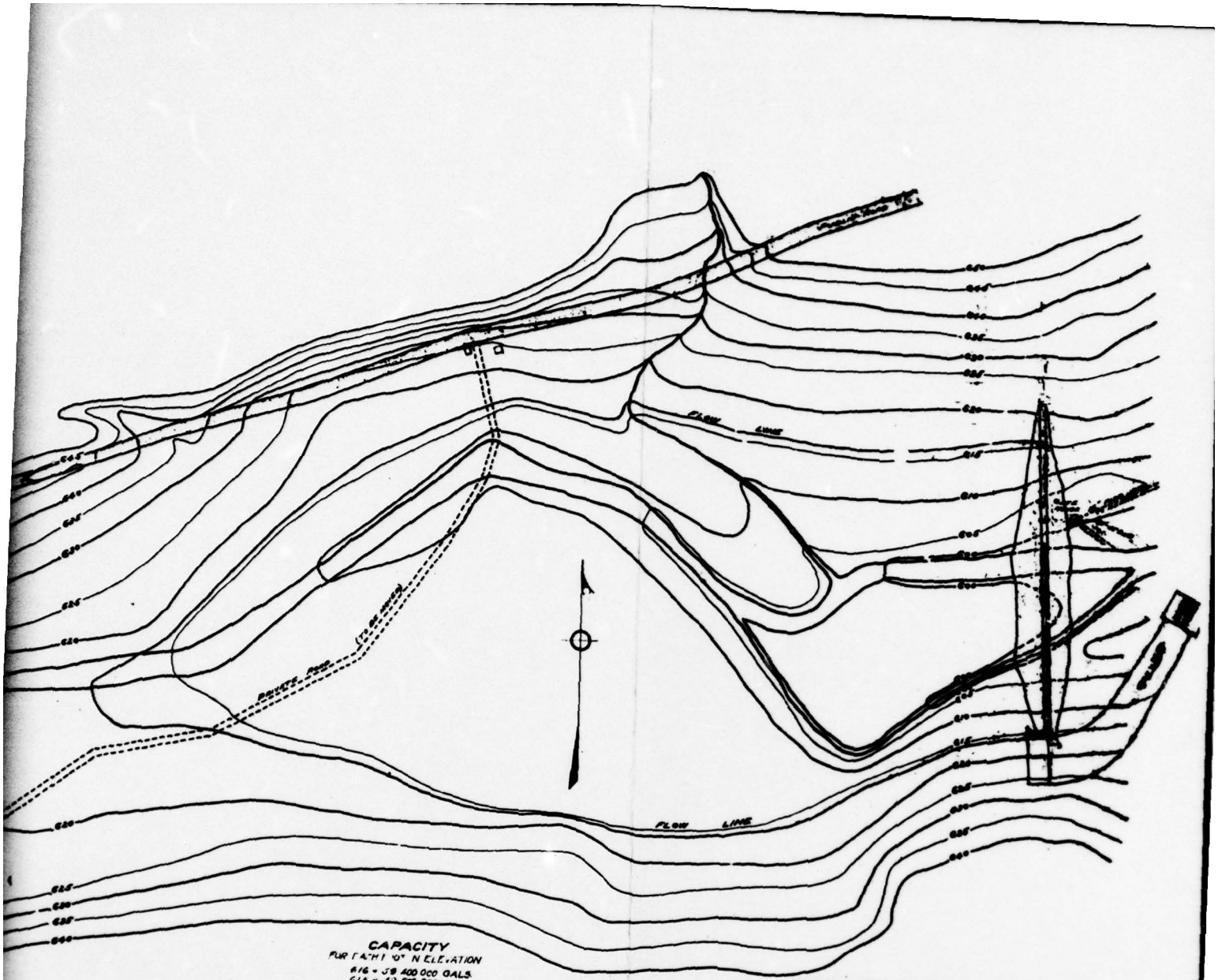


CAPACITY

FOR EACH FOOT IN ELEVATION

616	38 400 000	GALS
615	43 500 000	"
614	30 500 000	"
613	31 600 000	"
612	25 800 000	"
611	21 080 000	"
610	17 [illegible] 000	"
609	13 800 000	"
608	11 040 000	"
607	8 630 000	"
606	6 670 000	"
605	4 470 000	"
604	2 900 000	"
603	1 800 000	"
602	1 000 000	"
601	500 000	"
600	000 000	"

Assuming No. 23 Toe of Embankment was excavated to Flow Line.



CAPACITY

FOR EACH FOOT ELEVATION

616	59 400 000	GALS.
615	41 580 000	"
614	30 300 000	"
613	21 600 000	"
612	15 900 000	"
611	11 080 000	"
610	7 700 000	"
609	5 300 000	"
608	3 600 000	"
607	2 400 000	"
606	1 600 000	"
605	1 100 000	"
604	700 000	"
603	500 000	"
602	300 000	"
601	200 000	"
600	100 000	"

Assuming that 75% of Embankment was excavated from Flow Line.

CLEARVIEW WATER SUPPLY CO.

PLAN OF

LICKING CREEK STORAGE RESERVOIR

CAPACITY 65 400 000 GALS.

MILFORD TWP., JUNIATA CO. PA.

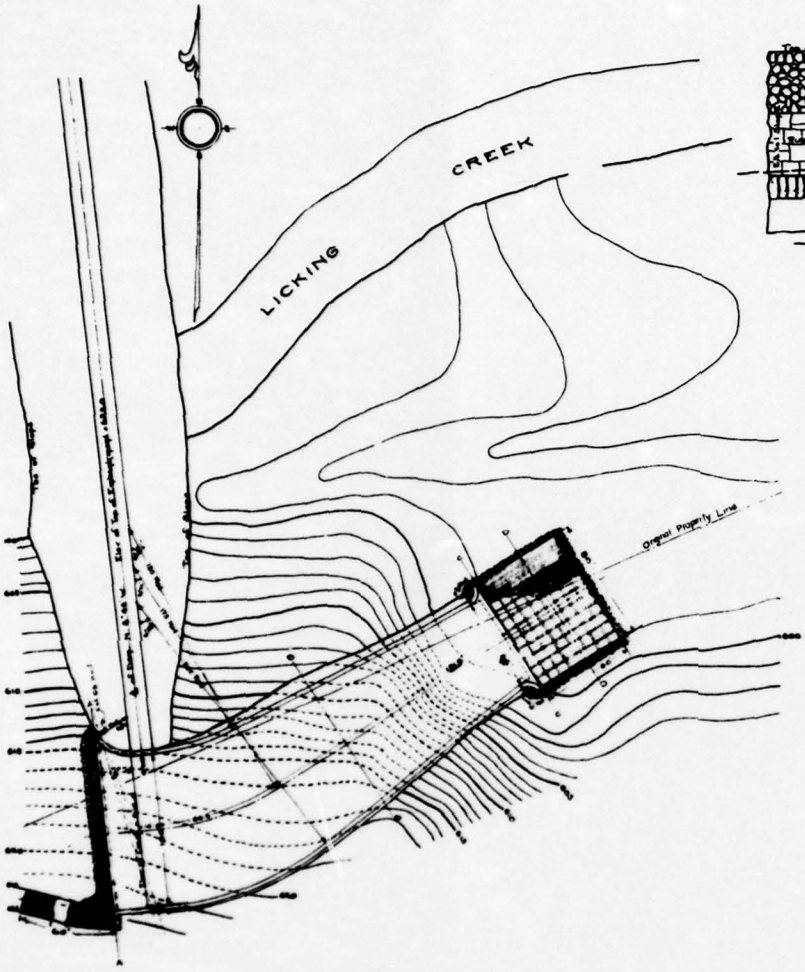
1906.

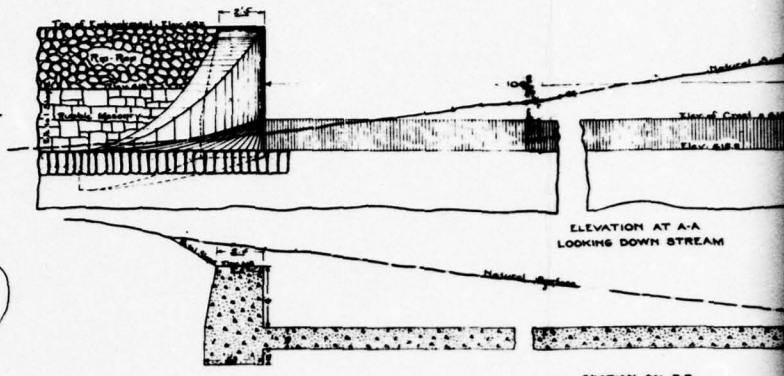
SCALE 1" = 100'

0 100' 200' 300' 400'

THE AMERICAN PIPE & C. CO.
ENGINEERS & CONTRACTORS,
140 N. BROAD ST., PHILA. PA.

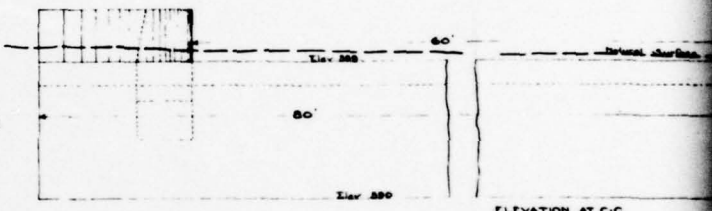
ARCHITECT



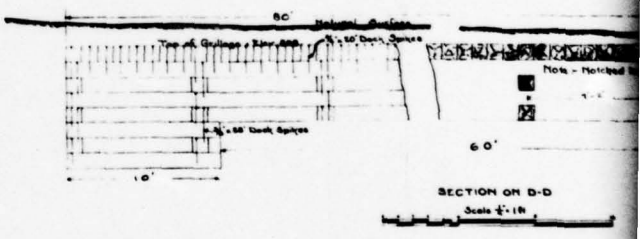


ELEVATION AT A-A
LOOKING DOWN STREAM

SECTION ON B-B



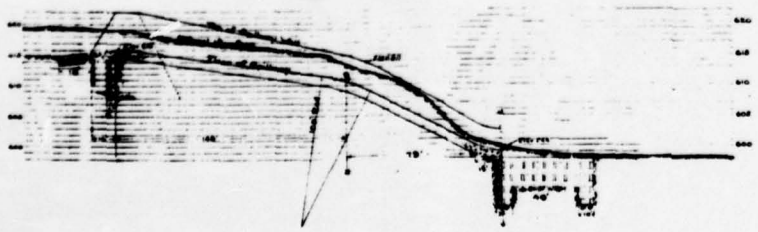
ELEVATION AT C-C
LOOKING UP STREAM



SECTION ON D-D

PROFILE ALONG CENTER LINE OF SPILLWAY

SCALE
HOR. - 1" = 40ft
VERT. - 1" = 10ft



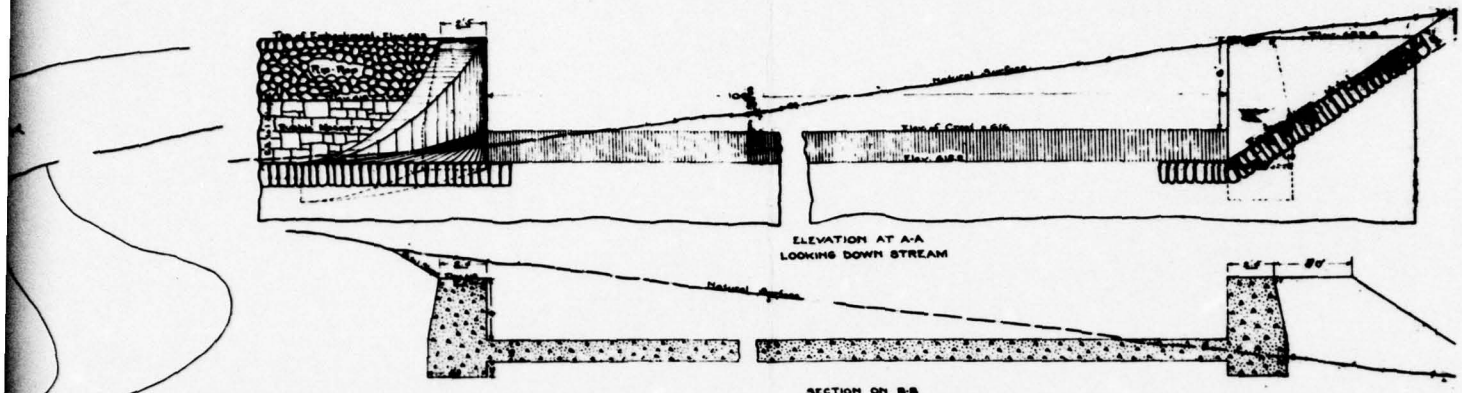
See ½ for change in Height of Dam

CLEARVIEW

LICKING CREE

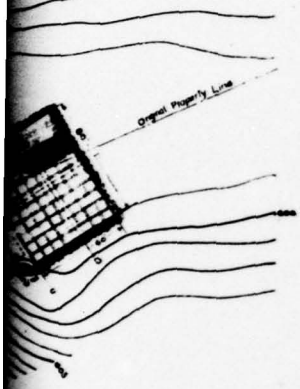
CAPA

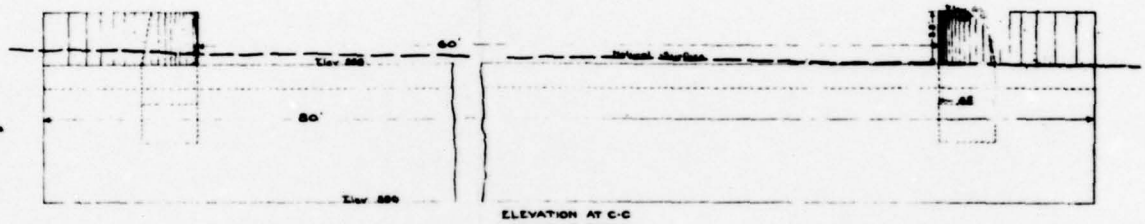
DETAI



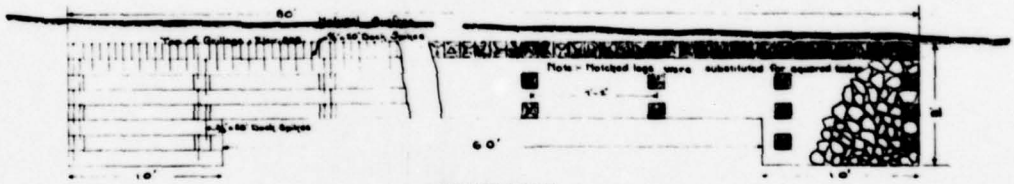
ELEVATION AT A-A
LOOKING DOWN STREAM

SECTION ON B-B

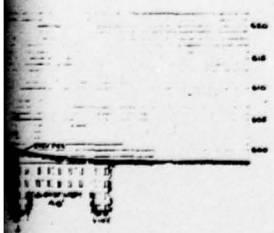




ELEVATION AT C-C
LOOKING UP STREAM



SECTION ON D-D



See ⅜" for change in Height of Dam

CLEARVIEW WATER SUPPLY CO.

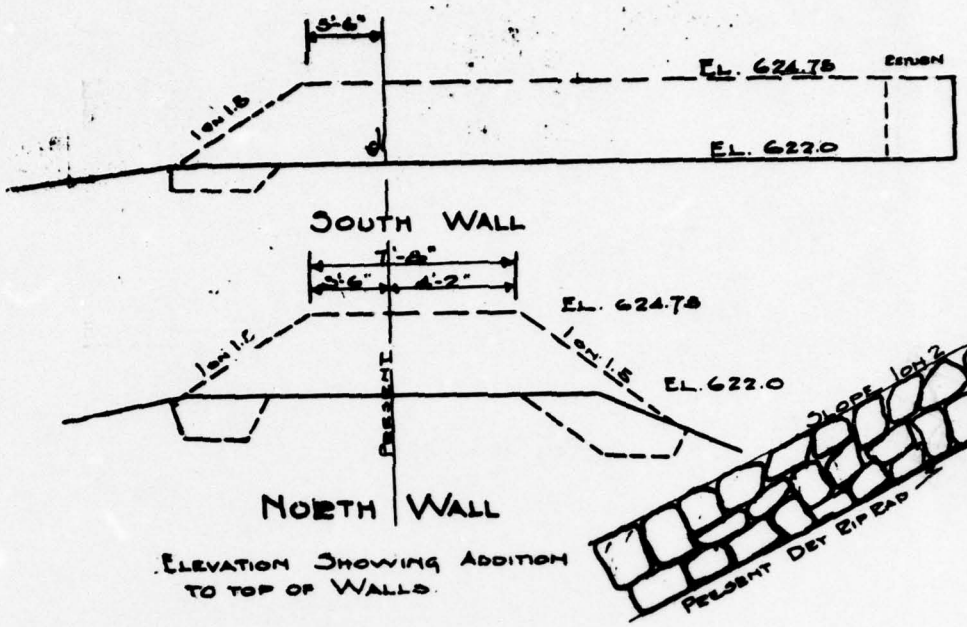
LICKING CREEK STORAGE RESERVOIR

CAPACITY 55,900,000 GAL.

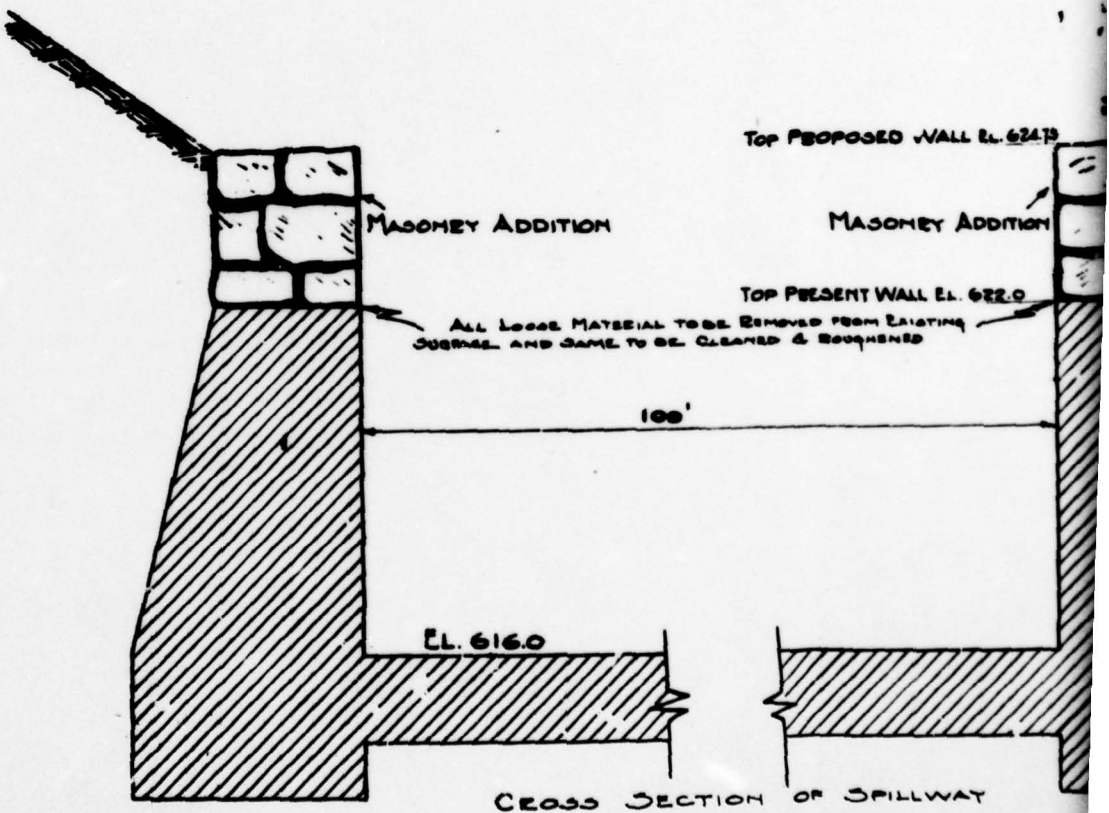
DETAILS OF SPILLWAY

1906

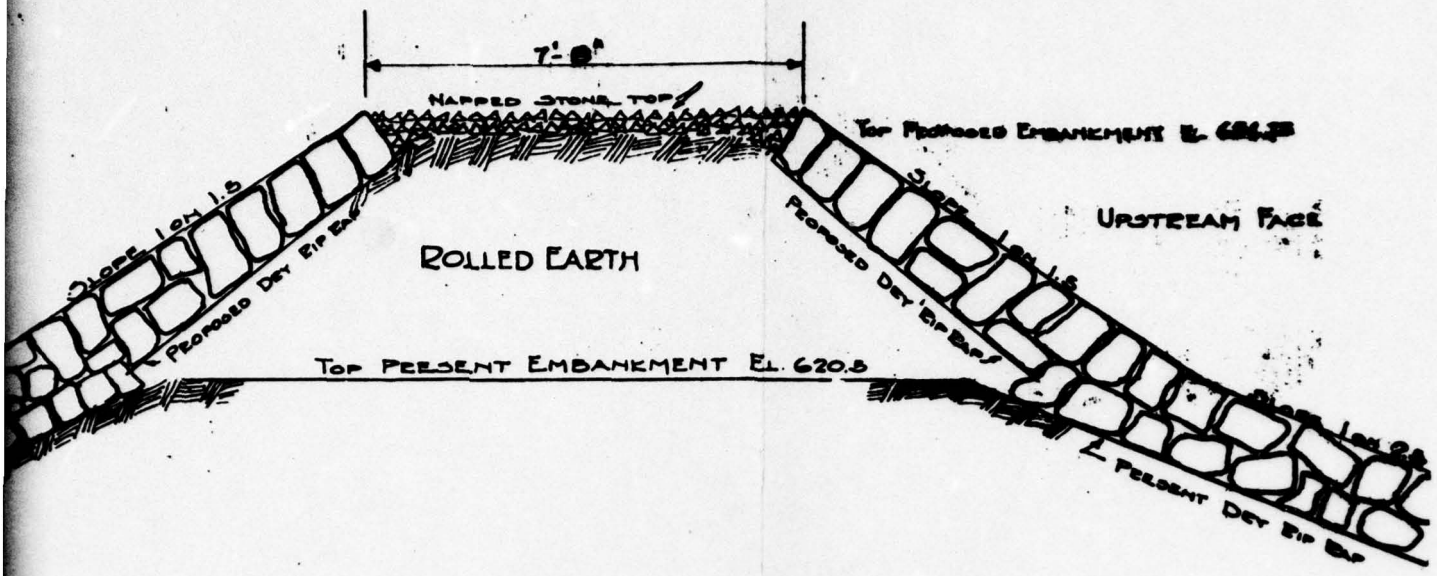
THE AMERICAN PIPE MFG. CO.
ENGINEERS & CONTRACTORS
112 N. BROAD ST., PHILA., PA.



ELEVATION SHOWING ADDITION TO TOP OF WALLS



CROSS SECTION OF SPILLWAY LOOKING UPSTREAM

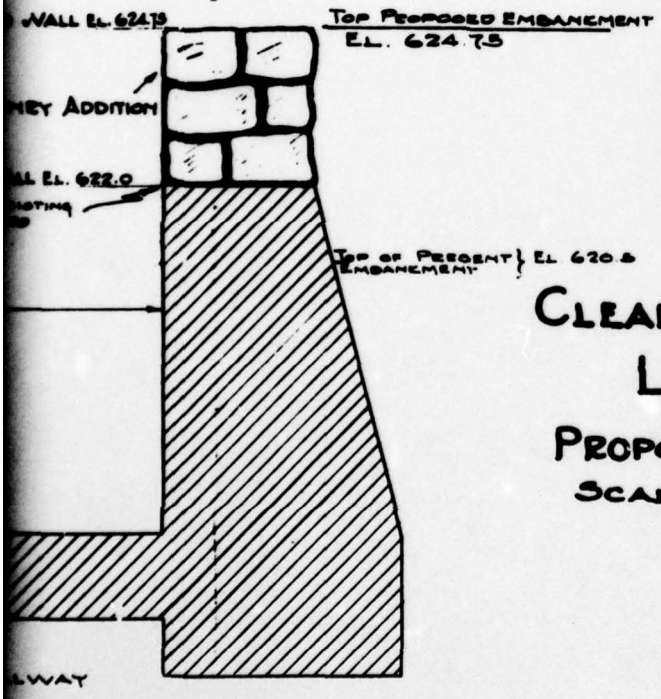


NOTE:

ALL STONE TO BE CLEANED FROM TOP OF EMBANKMENT AND SAME TO BE THOROUGHLY HARROWED BEFORE DEPOSITING NEW EARTH.

NEW EARTH TO BE PLACED IN NOT OVER 6" LAYERS, DAMPENED AND ROLLED WITH NOT LESS THAN 10 PASSES ON EACH LAYER OR STONE ROLLER.

EARTH TO BE PLACED FULL AND HAND DECKED AFTER BEINGING TO EL. 624.75



CLEARVIEW WATER SUPPLY COMPANY

LICKING CREEK DAM

PROPOSED INCREASE IN HEIGHT

SCALE 1"=2' E.R.W. APRIL 5, 1937

OFFICE OF MANAGER

AS CONSTRUCTED-1937

24
T6

APPENDIX F

GEOLOGY

General Geology:

The Clearview Reservoir and Licking Creek Dam lie within the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. This area is characterized by overturned and assymetric folds, local shearing and large, low-angle thrust faults. There is some faulting indicated approximately four miles to the southwest of the reservoir.

The bedrock is formed by the Silurian aged Bloomsburg (Sb) and McKenzie (Sm) Formations. The Bloomsburg Formation consists of red shale and siltstone with occurrences of sandstone, thin impure limestone, or green shale. It is moderately to highly fractured, with very close spacing. This formation is usually highly weathered to a moderate depth and should be excavated to sound material if it is to be used as a foundation material for heavy structures. The surface drainage is good while the joint, fault and bedding planes provide a low to medium magnitude source of secondary porosity.

The McKenzie Formation is a greenish-gray shale with interbedded gray, fossiliferous limestone. There is an intraformational breccia in the lower part of the formation. The fissile to thin beds are well developed. The joint pattern is platy while the limestones may have a blocky pattern. The joints are moderately well developed and may be highly abundant and closely spaced. This formation is also often highly weathered and must be excavated to sound material before use as a foundation material. The possibilities for collapse should be investigated where limestone is encountered. The surface drainage is good while the joints, bedding and cleavage planes provide a low magnitude source of secondary porosity.

Geologic Map of Licking Creek Dam Area

Bloomsburg Formation

Red, thin and thick bedded shale and siltstone with local units of sandstone and thin impure limestone, some green shale in places.

McKenzie Formation

Greenish gray, thin bedded shale interbedded with gray, thin bedded, fossiliferous limestone; shale predominant at the base; intraformational breccia in the lower part. Absent in Harrisburg quadrangle and to the east.

Scale: 1:250,000